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Report on best practices for limiting soil sealing and mitigating its effects

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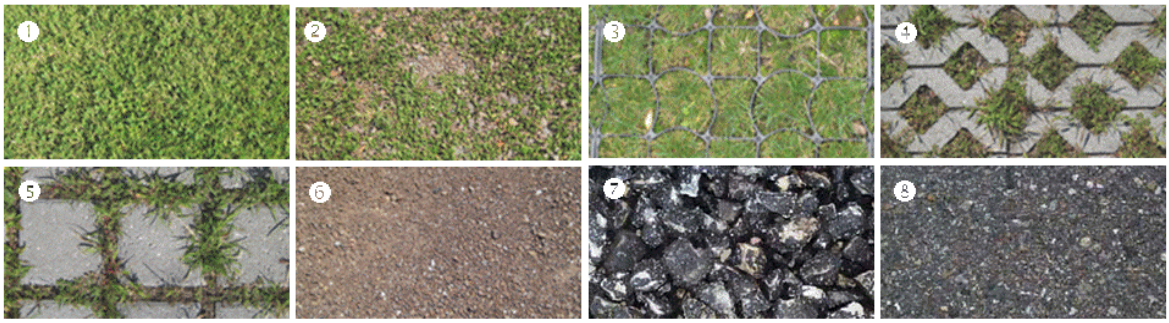

Overview of best practices for limiting soil sealing or mitigating its effects in EU-27

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CONTENTS

Executive Summary 15

1 Introduction 24
1.1 Definition of soil sealing and related terms 24
1.2 The broader context of soil sealing 27
1.3 Available data on artificial surface, sealing and land take 28
1.3.1 The extent of artificial surfaces and sealed surfaces in 2006 30
1.3.2 Changes in land use intensity between 1990 and 2006 32
1.3.3 Annual land take before and after 2000 35
1.3.4 Rapidly growing countries and regions 37
1.3.5 Summary 41

2 Overview of existing Policies to reduce and mitigate soil sealing in the EU and Member States 42
2.1 Relevant policy at EU level (short outline) 42
2.2 Austria 45
2.2.1 Land take and sealing 45
2.2.2 Policies of interest 46
2.2.3 Best practice 49
2.2.4 Conclusions 50
2.3 Belgium 51
2.3.1 Land take and sealing 51
2.3.2 Policies of interest 53
2.3.3 Best practice 55
2.3.4 Conclusions 55
2.4 Bulgaria (short country profile) 57
2.5 Cyprus (short country profile) 60
2.6 Czech Republic 62
2.6.1 Land take and sealing 62
2.6.2 Policies of interest 63
2.6.3 Best practice 65
2.6.4 Conclusions 65
2.7 Denmark 67
2.7.1 Land take and sealing 67
2.7.2 Policies of interest 68
2.7.3 Best practice 69
2.7.4 Conclusions 69
2.8 Estonia 70
2.8.1 Land take and sealing 70
2.8.2 Policies of Interest 71
2.8.3 Conclusions 72
2.9 Finland 73

2.9.1 Land take and sealing 73
2.9.2 Policies of interest 75
2.9.3 Best practice 76
2.9.4 Conclusions 77
2.10 France 78
2.10.1 Land take and sealing 78
2.10.2 Policies of interest 79
2.10.3 Best practice 81
2.10.4 Conclusions 81
2.11 Germany 82
2.11.1 Land take and sealing 82
2.11.2 Policies of interest 84
2.11.3 Best practice 90
2.11.4 Conclusions 91
2.12 Greece (short country profile) 92
2.13 Hungary (short country profile) 94
2.14 Ireland 96
2.14.1 Land take and sealing 96
2.14.2 Policies of interest 97
2.14.3 Conclusions 99
2.15 Italy 100
2.15.1 Land take and sealing 100
2.15.2 Policies of interest 102
2.15.3 Best practice 103
2.15.4 Conclusions 103
2.16 Latvia (short country profile) 104
2.17 Lithuania (short country profile) 106
2.18 Luxembourg 107
2.18.1 Land Take and sealing 107
2.18.2 Policies of interest 108
2.18.3 Conclusions 110
2.19 Malta (short country profile) 111
2.20 The Netherlands 112
2.20.1 Land take and sealing 112
2.20.2 Policies of interest 114
2.20.3 Best practice 115
2.20.4 Conclusions 116
2.21 Poland 117
2.21.1 Land take and sealing 117
2.21.2 Policies of interest 118
2.21.3 Best practice 119
2.21.4 Conclusions 119

2.22 Portugal 120
2.22.1 Land take and sealing 120
2.22.2 Policies of interest 121
2.22.3 Best practice 121
2.22.4 Conclusions 122
2.23 Romania (short country profile) 123
2.24 Slovakia 125
2.24.1 Land take and sealing 125
2.24.2 Policies of interest 126
2.24.3 Best practice 128
2.24.4 Conclusions 128
2.25 Slovenia 130
2.25.1 Land take and sealing 130
2.25.2 Policies of interest 132
2.25.3 Conclusions 133
2.26 Spain 134
2.26.1 Land take and sealing 134
2.26.2 Policies of interest 136
2.26.3 Best practice 137
2.26.4 Conclusions 138
2.27 Sweden (short country profile) 139
2.27.1 Land take and sealing 139
2.27.2 Policies of interest 140
2.27.3 Best practice 140
2.27.4 Conclusions 141
2.28 United Kingdom 142
2.28.1 Land take and sealing 142
2.28.2 Policies of Interest 144
2.28.3 Best Practice 147
2.28.4 Conclusions 147
2.29 Summary 149

3 Technical Measures to Mitigate soil sealing 153
3.1 Permeable surfaces 153
3.1.1 The principle of permeable surfaces 153
3.1.2 Overview of most common permeable surfaces 155
3.1.3 Gravel Turf 156
3.1.4 Plastic grass grids 159
3.1.5 Concrete grass grids 160
3.1.6 Water bound surfaces (macadam) 161
3.1.7 Permeable concrete pavements 163
3.1.8 Porous asphalt 165
3.2 Green Roofs 166

3.3 Legal requirements and incentives 169
3.3.1 Binding sealing limit in the City Dresden (DE) 169
3.3.2 Sealing Index in the Province Alto Adige (IT) 169
3.3.3 Permeable surfaces without planning permission (UK) 170
3.3.4 Binding sealing limit in the City Vienna (AT) 170
3.3.5 Tax incentives in several German municipalities 170
3.3.6 Green roof subsidies 170
3.4 Research 173
3.5 Best practice 173
3.5.1 Green tramway tracks 173
3.5.2 Sustainable Urban Drainage (SUD) Systems 174
3.5.3 Permeable Driveways 174
3.5.4 Parking for the masses 175
3.6 Summary 176

4 Compensation systems 178
4.1 Compensation payments 178
4.1.1 Compensation payments for agricultural land in the Czech Republic 178
4.1.2 Compensation payments for agricultural land in Slovakia 180
4.1.3 Ecological compensation for highway construction in the Netherlands 181
4.1.4 Eco Accounts in the German Federal States 182
4.1.5 Soil compensation account in Dresden (Germany) 183
4.1.6 Landscape Compensation Account in the Vienna agglomeration (Austria) . 184
4.2 Trading of soil certificates 185
4.3 Summary 186

5 Soil Quality Criteria 188
5.1 Urban Soil Evaluation in City Regions 188
5.2 Soil function evaluation in spatial planning (Hamburg) 190
5.3 Integration of soil protection in spatial planning (Salzburg) 190
5.4 Assessment of natural soils functions (Bavaria) 191
5.5 Summary 192

6 Networks 193
6.1 International Communities and Networks 193
6.2 International research projects 196
6.3 Funding Programmes 198
6.4 Summary 199

7 Conclusions & Recommendations 200
7.1 The impact of soil sealing 200
7.2 State and trend of land take and soil sealing in EU 27 200
7.3 Key recommendations 200
7.4 Addressing the right policy level 204

7.5 Key conclusions 205
Sources of Information 207
Annex 223

FIGURES

Fig. Soil sealing in EU 27: pressures, state and responses in the EU Member States. 22
Fig. 1 Visualisation of the terms “settlement area” / "artificial surface" and “sealed soil”. 25
Fig. 2 Example for urban sprawl (Munich) 26
Fig. 3 Soil Sealing in the context of driving forces, negative effects and possible responses. 28
Fig. 4 Sealed surfaces and artificial surfaces in the EU Member States. 30
Fig. 5 Artificial surfaces and sealed surfaces per capita in EU 27. 31
Fig. 6 The principle of decoupling growth of population and artificial surfaces. 33
Fig. 7 Changes in land use intensity in EU 27 between 1990 and 2006. 34
Fig. 8 EU27: Growth of artificial surfaces and population between 2000 and 2006. 37
Fig. 9 EU27: Increase in artificial surface per region (NUTS-3), 2000 - 2006. 39
Fig. 10 EU27: Share of sealed surface per region (NUTS3) 40
Fig. 11 Austria: Soil sealing per region in 2006 45
Fig. 12 Development of settlement area and population between 1950 and 2009 46
Fig. 13 Austria: Development of Land Take and Sealing between 2002 and 2009 47
Fig. 14 Belgium: Soil sealing per region in 2006. 51
Fig. 15 Belgium: Development of land take between 1985 and 2009. 52
Fig. 16 Brussels: Development of sealed surface between 1955 and 2006. 53
Fig. 17 Bulgaria: Soil sealing per region in 2006 57
Fig. 18 Spatial structure of urbanization in the Republic of Bulgaria 58
Fig. 19 Cyprus: Soil sealing per region in 2006 60
Fig. 20 Czech Republic: Soil sealing per region in 2006 62
Fig. 21 Czech Republic: Development of settlement area and population 63
Fig. 22 Denmark: Soil sealing per region in 2006 67
Fig. 23 Denmark: land use changes between 1965 and 2010 68
Fig. 24 Baltic Countries: Soil sealing per region in 2006 71
Fig. 25 Estonia: Major land use changes 72
Fig. 26 Finland: Sealed surface per region 74
Fig. 27 Finland: Development of urban areas and households 75
Fig. 28 Finland: Innovative housing “Eco Vikki”, respecting low energy and low soil consumption. 77

Fig. 29 France: Sealed surface per region 78
Fig. 30 France: Share of artificial surface per department 79
Fig. 31 France: Development of artificial surface in urban areas 80
Fig. 32 Germany: Soil sealing per region in 2006 82
Fig. 33 Germany: Average daily land take, 1992 - 2009 84
Fig. 34 Baden-Württemberg: Development of land take and population between 1950 and 2008 86
Fig. 35 Baden-Württemberg: Land take for settlement areas and traffic 88
Fig. 36 Saxony: Land Take for Settlement Area and Traffic 88
Fig. 37 Saxony: Land Take for Settlement Area and Traffic 90
Fig. 38 Greece: Soil sealing per region in 2006 92
Fig. 39 Hungary: Soil sealing per region in 2006 94
Fig. 40 Ireland: Soil sealing per region in 2006 96
Fig. 41 Italy: Soil sealing per region in 2006 100
Fig. 42 Italy: National soil sealing map 102
Fig. 43 Latvia: Soil sealing per region in 2006 104
Fig. 44 Lithuania: Soil sealing per region in 2006 106
Fig. 45 Luxembourg: Soil sealing per region in 2006 107
Fig. 46 Luxembourg: Development of built-up land and population 108
Fig. 47 Malta: Soil sealing per region in 2006 111
Fig. 48 The Netherlands: Soil sealing per region in 2006 112
Fig. 49 The Netherlands: Development of population and land take. 113
Fig. 50 Innovative housing: examples of private housing initiatives. 116
Fig. 51 Poland: Soil sealing per region in 2006 117
Fig. 52 Portugal: Soil sealing per region in 2006 121
Fig. 53 Portugal: The Morro Sé renewal project in Porto. 122
Fig. 54 Romania: Soil Sealing per region in 2006 123
Fig. 55 Slovakia: Soil sealing per region in 2006 125
Fig. 56 Slovakia: Development of key land use categories between 1996 and 2008. 126
Fig. 57 Slovakia: Development of Public Green Areas 127
Fig. 58 Slovenia: Soil sealing per region in 2006 130
Fig. 59 Slovenia: Development of population, dwellings and households between 1971 and 2007. 132
Fig. 60 Spain: Soil sealing per region in 2006 135
Fig. 61 Spain: Percentage of artificial surface along the coast. 136
Fig. 62 Urban rehabilitation projects in Catalonia 138

Fig. 63 Sweden: Soil sealing per region in 2006 139
Fig. 64 United Kingdom: Soil sealing per region in 2006 143
Fig. 65 England: New dwellings built on previously developed land 144
Fig. 66 Difference between impermeable and permeable surface 155
Fig. 67 Overview of most common surfaces 156
Fig. 68 Gravel turf 157
Fig. 69 Grass grids – examples 159
Fig. 70 Concrete grass grids – examples 160
Fig. 71 Water bound surfaces - examples 161
Fig. 72 Permeable concrete pavers – examples 163
Fig. 73 Left: principle of permeable concrete blocks, right: parking area with permeable concrete blocks 164
Fig. 74 Porous asphalt – examples 165
Fig. 75 Principal Green Roof components 167
Fig. 76 Green roof types: extensive, semi-intensive, or intensive 167
Fig. 77 Graz (AT), Mulhouse (FR): Green tramway tracks 174
Fig. 78 UK: Examples for Sustainable Urban Drainage Systems 174
Fig. 79 UK: The Ealing Front Garden Project 175
Fig. 80 Germany: EXPO 2000 parking area in Hannover 176
Fig. 81 Austria: Parking area of the Salzburg soccer stadium. 176
Fig. 82 Development of desealing in Dresden 184
Fig. 83 Overview of networks and communities with relevance to reduction of soil sealing and land take. 193
Fig. 84 The “prevent – limit – compensate” principle for soil sealing. 201

TABLES

Tab. Soil sealing in EU 27: pressures, state and responses in the EU Member States. 17
Tab. 1 Overview of data sources for the assessment of artificial surface, sealing and land take in EU 27. 28
Tab. 2 Mean annual land take per before and after 2000. 36
Tab. 3 Germany: Growth of settlement and traffic area between 1960 and 1997 in East and West Germany. 83
Tab. 4 The Netherlands: Growth scenarios for 2040 114
Tab. 5 Average annual land take in Slovenia between 1996 and 2006. 131
Tab. 6 Soil sealing in EU 27: pressures, state and responses in the EU Member States. 151
Tab. 7 Comparison of benefits and limitations of most common permeable surfaces (in relation to asphalt) 156
Tab. 8 Gravel turf – technical description of layers and building material 157
Tab. 9 Water bound macadam – technical description of layers and building material 162
Tab. 10 Permeable concrete pavers – technical description of layers and building material 164
Tab. 11 General features of green roof types 168
Tab. 12 Yearly income of the State Environment Funds 179
Tab. 13 Fees for the conversion of agricultural land 180
Tab. 14 Compensation payments for agricultural soils in Slovakia 181
Tab. 15 Selected planning recommendations from case studies 189
Tab. 16 Identified international networks and communities with relevance to soil sealing. 194
Tab. 17 Identified international research projects 196
Tab. 18 Funding programmes 199

PREFACE

This report is based on information received from experts dealing with spatial planning, soil protection, building techniques, and research from all over the European Union. More than 60 specific written answers were received by email and in 40 cases telephone interviews were conducted to back-up obtained information.

In addition to this work an intensive literature survey was carried out. Official publications and legal documents are to a great extent available via the internet. Where ever possible relevant hyperlinks are indicated.

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EXECUTIVE SUMMARY

In the European Union (EU) about 1,000 km² were annually subject to land take for housing, industry, roads or recreational purposes between 1990 and 2006. This is exceeding the size of Berlin. About half of this surface is actually sealed by buildings, roads and parking lots. Soil sealing means covering of the soil by a completely or partly impermeable artificial material (asphalt, concrete, etc), causing an irreversible loss of soil and its biological functions and loss of biodiversity, either directly or indirectly, due to fragmentation of the landscape.

Methodology

Remote sensing data

To assess land take and soil sealing within the EU, CORINE Land Cover data were used.

Data sets on *land take* are available for the years 1990, 2000 and 2006 (but not for all Member States, for which best proxies have been used). Concerning *soil sealing*, data covering the entire EU27 is available for the year 2006.

Due to the resolution of CORINE Land Cover, the figures for land take and sealing presented in this report in all likelihood underestimate the real extent of these phenomena; sometime they differ significantly from national inventories.

Consultation of experts

In order to describe relevant policy measures of the Member States, more than 40 expert interviews were conducted and more than 60 written answers were received by e-mail. In addition to this work an intensive literature survey was carried out.

Land take, artificial surfaces and soil sealing in EU27

Pressures and driving forces of soil sealing

Most social and economic activities depend on the construction, maintenance and existence of sealed areas and developed land. New housing, business locations and road infrastructure are mostly realised on undeveloped land outside or at the border of existing settlements, usually resulting in new soil sealing.

Land take

Land take is the increase of artificial surfaces (housing areas; green urban areas; industrial, commercial and transport units; road and rail networks; etc) over time. Between 1990 and 2000, land take was around 1,000 km² per year (275 hectare per day) within the territory of EU27 and artificial surfaces increased by 5.7 % (from 176,150 to 186,200 km²). Since then, land take has "slowed down" to 920 km² per year (252 hectare per day) and artificial surfaces have increased by a further 3 % (artificial land stood at 191,200 km² in 2006).

However, between 2000 and 2006 exceptionally high increases of artificial land with more than 7,5 % were observed in the Netherlands, Portugal, Ireland, Cyprus, and Spain. Several individual regions are also affected by a rapid increase of artificial surfaces, among them half of the Dutch regions, eight provinces in Italy (Vercelli, Lodi, Verona, Piacenza, Parma, Campobasso, Matera, Catanzaro), three French départments (Vendée, Tarn-et-Garonne, Corrèze), the Poznan region in Poland, Western Styria in Austria, the Põhja-Eesti region in Estonia, and the Jugovzhodna region in Slovenia.

Between 1990 and 2006 a slight decrease of annual land take can be observed. Growth of artificial surface and population growth are moving closer and annual land take per capita decreased from 2.1 to 1.9 m².

Significant land take decreases per capita were realised in Belgium, Luxembourg, and Germany and moderate decreases in Poland, Slovakia, Italy, Czech Republic, France, the Netherlands, Portugal and Ireland. Reasons for this trend were mainly a general saturation of large land developments (in particular road networks) and in a few cases rapidly growing population as for instance in Ireland (+11.4 %) and Luxembourg (+8.2 %).

In comparison, in most new Member States (except Poland, Czech Republic and Slovakia), and Austria, Denmark and Spain land take per capita was increasing. This can be reasoned with either booming economy, realisation of numerous large infrastructure projects or shrinking population.

State of artificial surfaces

4.1 %, 4.3 % and 4.4 % of the EU territory was classified as artificial surface in 1990, 2000 and 2006 respectively. This corresponds to a 8.8 % increase of artificial surface in the EU between 1990 and 2006. In the same period, population increased by only 5 %. In 2006 each EU citizen disposed of 389 m² of artificial surfaces, which is 3.8 % or 15 m² more compared to 1990.

State of soil sealing

In 2006, almost 100,000 km² or 2.3 % of the EU's territory are actually sealed and each EU citizen was on average stocked with 200 m² sealed surface. Member States with high sealing rates exceeding 5 % of the national territory are Malta, the Netherlands, Belgium, Germany, and Luxembourg. Furthermore, individual regions with high sealing rates exist all over the EU and include all major urban agglomerations, and most of the Mediterranean regions.

As CORINE data sets on sealing are only available for the year 2006 at the time of this study, it is not possible to give soil sealing trends at EU or Member State level at this stage. Land take cannot be generally used as a proxy, even if sealed surfaces are major components of artificial surfaces, because their shares vary remarkably among Member States.

Measures and policies in the Member States

Soil sealing is caused by several driving forces and creates a variety of negative but also beneficial effects, both of which affect the 27 EU Member States differently.

The following overview reflects how Member States are actually affected by the pressures that lead to increased soil sealing, the actual state of sealing within their territory (in decreasing order), whether or not responses at the policy level have already been initiated, and if a policy target exists or not.

Table Soil sealing in EU 27: pressures, state and responses in the EU Member States.
Source: Umweltbundesamt, 2010

Country	Pressures (unsustainable trends 2000 - 2006)	State (sealing)	Responses	Policy Target
Malta	insignificant land take despite rapid population growth	13 % high	no specific measures in place	N
Netherlands	artificial surface is growing faster than population	8.1 % high	several measures implemented	Y
Belgium	annual land take is decreasing despite growing population	7.4 % High	several measures implemented	Y (Flanders)
Germany	land take and population are stagnating	5.1 % high	several measures implemented	Y
Luxembourg	annual land take is decreasing, steady population growth	4.9 % high	several measures implemented	Y
Cyprus	land take is growing faster than population	3.6 % high	no specific measures in place	N
Denmark	land take is growing faster than population	3.6 % high	several measures implemented	N
United Kingdom	annual land take is decreasing despite growing population	3.4 % high	several measures implemented	Y
Hungary	land take is growing despite shrinking population	3.2% high	no specific measures in place	N
Czech Republic	land take is slowing down, population is stagnating	3.2 % high	several measures implemented	N
Portugal	land take is growing faster than population	3.1 % high	first measures initiated	N
France	annual land take is decreasing despite growing population	2.8 % medium	first measures initiated	Y
Italy	annual land take is decreasing despite growing population	2.8 % medium	first measures initiated	N
Poland	land take is slowing down, population is shrinking	2.4 % medium	first measures initiated	N
Slovakia	land take is slowing down, population is stagnating	2.4 % medium	several measures implemented	N
Lithuania	land take is growing despite shrinking population	2.2 % medium	no specific measures in place	N
Austria	annual land take is decreasing, steady population growth	1.9 % medium	several measures implemented	Y
Bulgaria	land take is growing despite shrinking population	1.8 medium	no specific measures in place	N
Slovenia	insignificant land take, population is stagnating	1.8 % medium	several measures implemented	N
Ireland	land take is slowing down, steady population growth	1.6 % low	first measures initiated	N
Romania	land take is growing despite shrinking population	1.6 % low	no specific measures in place	N
Spain	land take is growing faster than population growth	1.4 % low	first measures initiated	N
Greece	data gap	1.3 % low	no specific measures in place	N
Latvia	land take is growing despite shrinking population	1.1 % low	no specific measures in place	N
Estonia	land take is growing despite shrinking population	0.9 % low	no specific measures in place	N
Finland	insignificant land take despite growing population	0.6 % low	first measures initiated	N
Sweden	insignificant land take despite growing population	0.4 % low	several measures implemented	N

The column **"Pressures"** refers to unsustainable trends between 2000 and 2006 and distinguishes between three categories: *Green colour* stands for insignificant land use pressures, i.e. insignificant land take in relation to population growth, *Yellow colour* means moderate land use pressures, like moderate land take in relation to population growth, and *Red Colour*, refers to high land use pressures, in particular to land take increasing faster than population growth[1].

- Unsustainable land use trends can be observed in Cyprus, Denmark, the Netherlands and Portugal where land take is growing considerably faster than population growth. Furthermore, there are several new Member States also affected by unsustainable land use trends due to continuing land take and at the same shrinking populations.
- Positive land use trends can be observed in Austria, Belgium, Finland, France, Luxembourg, Italy, Malta, Slovenia, and Sweden, where land take is either insignificant or lower than population growth.

The column **"State"** refers to the share of sealed surfaces out of the total national territory, in decreasing order: *Green colour* stands for a low sealing rate with less than 1.6 %, *Yellow colour* refers to a moderate sealing rate ranging between 1.6 % and 3 %, and *Red Colour* indicates high sealing rates with more than 3 %. For the definition of thresholds the principle of arithmetic average was used.

- The highest sealing rates can be observed in Malta with 13 %, the Netherlands with 8 %, Belgium with 7.4 %, Germany and Luxembourg each with around 5 %, and Cyprus and Denmark, each with 3.6 %.
- The lowest sealing rates can be observed in Ireland and Romania (each with 1.6 %), Spain (1.4 %). Greece (1.3 %), Latvia (1.1 %), Estonia, Finland and Sweden (each with less than 1 %).

The column **"Responses"** refers to the intensity of already implemented measures: *Green colour* indicates that several measures to reduce land take have been implemented, *Yellow colour* refers to the fact that first measures to reduce land take were implemented, and *Red Colour* that no specific measures to reduce land take exist. The following most promising measures and policies to mitigate land take and soil sealing were identified:

- Improvement of quality of life in large urban centres. Run down city quarters with decreasing population can be found in most European metropolitan areas. The phenomenon of people moving to urban fringes and leaving behind city centres with decreasing population is widespread. As a result distances between new dwellings and city centres are growing continually and mainly car dependency is increasing. Several urban renewal programmes have been launched recently with the objective to attract new residents and create new jobs in central urban areas of decline. Best practice examples in this respect are (1) the urban renewal programmes of *Porto* and *Lisbon* and the neighbourhood renewal programme in *Catalonia* both of which are supported by the European Regional Development Funds, (2) the *Västra hamnen* project in Malmö which is built on derelict harbour premises providing 1,000 new dwellings with the lowest possible environmental impact, (3) the *Erdberger Mais* development in Vienna which is realised on five inner urban brownfield areas, providing housing for 6,000 new inhabitants and 40,000 work places, and (4) the *Randstad* programme in the Nether-

[1] The definition of thresholds is based on the principle of decoupling population growth and growth of artificial surfaces and is visualised in Fig. 6.

lands which puts special emphasis on improving the attractiveness of inner urban areas in the metropolitan agglomeration of Amsterdam, Rotterdam, and The Hague.

- Brownfield redevelopment. Initial or supportive funding to encourage new infrastructure developments on Brownfield sites exists in several Member States and is usually coordinated by designated organisations. Brownfield redevelopment projects are mostly realised in the form of private public partnerships. (1) The *English Partnerships* is probably the most experienced public land developer in the EU and provides funding for social housing developments on derelict areas. (2) France disposes of a network of more than 20 public land development agencies, which among other activities develop Brownfield land for social housing. (3) The land development agencies *Czech Invest* and *Invest in Silesia* are in charge of developing major industrial Brownfield sites for new industrial investors. (4) In Flanders specific contracts (Brownfield covenants) are negotiated between the government and private investors to promote Brownfield redevelopment.
- Protection of agricultural soils and landscapes. Some Member States have established specific policies to avoid further land take and sealing on their best agricultural soils and most valuable landscapes. This is the case (1) in Spain, where building activities within the first 500 metres from the sea are strictly controlled, (2) in France and the Netherlands, where designated “green and blue” landscapes are protected from infrastructure developments, and (3) in the Czech Republic and Slovakia, where the conversion of top agricultural soils requires a fee.

The last column refers to the existence of **policy targets** with regard to reducing land take.

- Sustainable spatial planning. The majority of the EU Member States have established the principle of sustainable development in their key spatial planning regulations, referring to economic use of soil resources and avoidance of unnecessary urban sprawl. However, the existence of relevant regulations does not give any insight on the effectiveness of implemented measures.
- Policy targets for land take. Quantitative limits for annual land take exist only in six Member States: Austria, Belgium (Flanders), Germany, Luxembourg, the Netherlands, and the United Kingdom. In all cases the limits are indicative and are used as monitoring tools.

Technical measures to mitigate soil sealing

Permeable surfaces can help to conserve soil functions and mitigate the effects of soil sealing to a certain extent. They contribute to the local water drainage capacity and can in some cases also fulfil biological or landscaping functions. Another advantage is their positive contribution to the micro-climate thereby trapping the heat and moderating temperatures in the area. Unsealed, green shaded surfaces have lower surface temperatures than sealed surfaces, the difference can amount to up to 20 °C. In the case of storm water a parking area built with permeable surfaces discharges the local sewage system by at least 50 % compared to a conventional asphalt surface. It can even be designed as independent system without discharges to the local sewage system.

A broad range of materials and concepts is available for permeable surfaces. In addition to their clear ecological advantages most types of surfaces have lower lifespan costs compared to conventional impermeable surfaces. With regard to sustainability most permeable surfaces are made of materials that are locally available and reusable. Key barriers to implementation are currently the fact that site specific know-how and building competence is required to construct them correctly. Furthermore, regular maintenance is needed to make sure that they function properly. Parking areas have the greatest potential for permeable surface applica-

tion, in particular large parking areas in urban fringes. Most advanced in this respect is the United Kingdom, where permeable surfaces are broadly used – even in big cities – and where research is continuously developed and many guidelines exist.

Green roofs generate new green space and create an added value to the quality of living, particularly in very densely built-up areas. At the city planning level several European towns provide either tax incentives or funding schemes for the construction of green roofs as this is the case in many Dutch towns (i.e. Groningen, Rotterdam, Amsterdam, The Hague), in several German towns (Berlin, Bonn, Munich and Stuttgart), in Copenhagen (Denmark), Linz (Austria), and probably other European cities as well.

Compensation of soil loss

Two principles were identified, namely compensation fees and compensation measures. Compensation fees for the conversion of agricultural soils into building land are being charged in the Czech Republic and Slovakia. The income of the fee sometimes is directed to an environmental fund. Compensation measures build on the principle that soil consumption and hence the loss of soil functions (habitats for species, food production, drainage capacity, carbon sequestration etc.) is compensated with restoration of soil functions somewhere else. This principle is already realised in several German Federal States through eco accounts and is currently tested in Austria.

Consideration of soil quality along planning processes

The integration of soil protection and hence protection of soil functions in spatial planning is relatively new and is a result of a general commitment to sustainable spatial planning. At the international level the Interreg project TUSEC-IP established criteria how to respect soil functions in spatial planning. The project results are increasingly influencing spatial planning standards, as this is the case in Germany, Northern Italy and Austria. Indicative guidelines to consider soil functions in spatial planning procedures exist in all German Federal States, in two Austrian Provinces, and in the autonomous province of Bolzano in Italy. Awareness of soil functions and how to respect them in spatial planning is increasingly growing.

International Networks and Research[2]

At the level of international networks only very few aspects concerning soil sealing are currently covered: monitoring, exchange of knowledge and raising awareness are partly covered but there are no international initiatives with the objective to push the issue on the EU political agenda.

Apart from the European Structural Funds, which have currently an action line for urban renewal and Brownfield redevelopment, there are hardly any funding programmes which directly or indirectly address soil sealing. The German REFINA programme funds research related to land take and is for sure the largest and most remarkable research programme in this thematic field. It is therefore highly recommended to inform other Member States of selected research results and documents produced by REFINA.

With regard to international research initiatives a lot of promising work has been completed or is currently being carried out which will hopefully influence future policy systems. To give a few examples: within the project URBAN SMS an urban soil management strategy is being developed with the aim to consider soil quality and quantity more comprehensively in spatial planning in central Europe. The project COBRA-MAN focuses on establishing competence

[2] Full names of project acronyms, websites and descriptions can be found in chapter 6.

and the project CIRCUSE capitalises on inner-urban development by introducing the “prevent & reuse” logic of material streams into spatial planning. The project GREEN-CONCRETE developed robust green surfaces which can be built by using recycling material in the subsurface. The surfaces have a great potential to be used in large parking areas at recreational sites but also at higher frequented sites such as super-markets and railway stations.

Recommendations

Efficient protection of soils from further sealing can only be achieved by following an integrated approach, requiring the full commitment of all policy levels, by improving awareness and competence within all concerned stakeholders, by freezing counterproductive policies, by establishing clear financial incentives, and by introducing binding legal requirements. In this context a three-tiered approach based on the *prevent, limit, and compensate principle* is proposed, similar to the logic used in waste materials streams (see Figure below). The proposed approach recommends specific measures for specific policy levels.

Tier 1: Prevention of Soil Sealing.
To "pave the way" for successful prevention of soil loss the following basic principles need to be implemented at the policy level:

- to establish the principle of sustainable development in spatial planning
- to define realistic land take targets for the national and the regional level
- to integrate the "prevent, limit, and compensate" principle for soil loss in all policy sectors
- to streamline existing funding policies accordingly (i.e. public funding for private housing, subsidies for developments on the green field sites, commuter bonuses, etc.)

According to the individual regional needs the following key action lines are proposed:

- to steer new developments to already developed land
- to provide financial incentives for the development of brownfield sites
- to improve the quality of life in large urban centres
- to make small city centres more attractive to counteract dispersed settlement structures in rural regions with shrinking population
- to designate agricultural soils and valuable landscapes with development restrictions

Tier 2: Limit Soil Sealing as far as possible
Whenever soil loss is unavoidable, mitigation measures shall be implemented as far as possible, this can be realised by,

- respecting soil quality along planning processes and steering new developments towards less valuable soils
- by applying technical mitigation measures to conserve at least a few soil functions (i.e. permeable surfaces on parking areas)

Tier 3: Compensate soil losses
For specific infrastructure developments even top quality soils will be lost and valuable landscapes fragmented. In such cases controlled compensation measures shall be carried out to facilitate soil restoration measures somewhere else where they make sense. This can be achieved by,

- establishing qualified compensation measures
- facilitating new opportunities

Figure: The "prevent – limit – compensate" principle for soil sealing.
Source: Umweltbundesamt, 2010

At EU level it is recommended that the *prevent, limit, and compensate principle* is integrated in the funding objectives of the European Structural Funds and that best practices with regard to preventing soil loss are promoted via the European Territorial Co-operation Programme and the European Research Framework Programme

At the National Level it is recommended that Member States (i) monitor annual land take and soil sealing, (ii) require that regions define realistic targets for annual land take according to their growth forecasts for population and economy, (iii) promote awareness how to avoid unnecessary soil sealing, (iv) provide clear financial incentives for inner urban development, and (v) abolish funding mechanisms that support further land take and disperse settlement structures.

At the Regional Level it is recommended that regions (i) define specific regional targets for their annual land take under full consideration of the *prevent, limit and compensate principle*, (ii) promote and organise training courses for policy makers at the local level and cultivate awareness for soil functions by means of educational programmes at schools, (iii) establish soil compensation mechanisms for soil loss, and (iv) make sure that regional funding schemes are in line with the *prevent, limit and compensate principle* for soil sealing.

Local planning authorities shall make sure that new building activities for housing and public infrastructure are being realised with the least possible impact on soil functions. In this respect it is recommended that (i) soil quality and alternative scenarios are as far as possible considered during the planning phase, (ii) green areas at the fringe of settlements are protected, (iii) inner urban development and Brownfield redevelopment are being promoted, and that (iv) building permits prescribe sealing limits.

Key conclusions

Policy measures to reduce land take and negative impacts of soil sealing exist above all at the regional or city planning level. Only very few Member States have defined national policies which explicitly address these issues. Awareness for the need of reducing annual land take is increasing though, as can be seen in the numerous initiatives which have recently been launched in the Member States.

In view of rising energy prices, food and biomass production within the EU are gaining importance and the demand for productive soils is growing. Despite several initiatives it can be concluded that soils are not adequately protected in the EU. Soil quality is rarely respected along planning processes and compensation of soil losses hardly realised.

Economic growth is still highly depending on land take and soil sealing. In order to decouple economic growth from land take and soil sealing, it is suggested to strictly follow the *prevent, limit and compensate principle* for soil sealing. Several elements of this logic are already being realised in some Member States as described in the section above and in the country profiles of this report. However, limitations to soil sealing are primarily based on voluntary agreements and non binding measures.

It can be expected that single Member States will refrain from applying stricter regulations to protect their soils from sealing as this could represent a market disadvantage.

It can be concluded that binding measures to prevent and limit soil sealing as far as possible need to be established at the EU level. A common regulatory framework in particular for regions with high land use pressures can be considered as the only solution to achieve better progress with regard to a sustainable use of the EU's soils.

They paved paradise
and put up a parking lot
with a pink hotel, a boutique
and a swinging hot spot.
Don't it always seem to go,
that you don't know what you've got
'til it's gone
Joni Mitchell, 1969

1 INTRODUCTION

In the European Union (EU) about 1,000 km² are annually subject to land take for housing, industry, roads or recreational purposes[3]. This corresponds to about the size of Berlin. About half of this surface is actually sealed by buildings, roads and parking lots. Soil sealing means an irreversible loss of soil and its biological functions and loss of biodiversity, directly by habitats loss or indirectly due to fragmentation of the landscape.

The current report focuses on measures which aim to reduce soil sealing or mitigate its effects. Soil sealing is caused by several driving forces and creates a variety of negative but also beneficial effects, both of which affect the 27 EU Member States differently. As a consequence the intensity of responses is also subject to great variations throughout the European Union. This chapter aims at structuring the topic soil sealing by (1) providing key definitions for soil sealing and related terms, (2) explaining soil sealing in the context of driving forces and negative effects, and (3) analysing available data with regard to soil sealing. All subsequent chapters deal with reduction and mitigation measures.

1.1 Definition of soil sealing and related terms

Most of the following terms and their definitions were derived from the Environmental Assessment of Soil for Monitoring project (ENVASSO) which published recommendations for the monitoring of all soil threats including soil sealing [1]. Terms related to urbanisation processes were taken from the European Environment Agencies (EEA) report "*Urban Sprawl. The ignored challenge*" [2].

Artificial Surfaces

The term "artificial surface" is used in the CORINE Land Cover nomenclature and refers to "continuous and discontinuous urban fabric (housing areas), industrial, commercial and transport units, road and rail networks, dump sites and extraction sites, but also green urban areas.

[3] According to the CORINE Land Cover Statistics the annual mean value for new artificial surface amounted to 97,406 hectare (or 974 km²) between 1990 and 2006. The size of Berlin is 892 km², and of London 1,572 km².

Settlement areas

Settlement areas are also known as “urban land” and “built-up land” and include areas for housing, industrial and commercial activities, areas for health care, education, and nursing infrastructure, traffic areas (streets and railways), cemeteries, recreational areas (parks and sports grounds), and dumps sites. In local land use plans this category usually corresponds to all land uses beyond agriculture, nature, forests, and water courses. Artificial surfaces and settlement areas refer to the same structures, whereas settlement areas are defined by spatial planners and artificial surfaces are measured by means of remote sensing.

Sealed soils

Sealed soils can be defined as the destruction or covering of soils by buildings, constructions and layers of completely or partly impermeable artificial material (asphalt, concrete, etc.). It is the most intense form of land take and is essentially an irreversible process. Sealed land is a subset of the above mentioned category; i.e. land consumed by development of settlements, infrastructure, and commercial and industrial areas. An indicator of the intensity of land take is the proportion of the total built-up land area which is sealed.

Fig. 1 left shows a typical suburban pattern, with houses, gardens, drive ways and yards. This pattern corresponds to the term “settlement area” or “artificial surface”. On the right side the sealed soil of the same settlement area is shown in black. In this case about 60 % of the settlement area is actually sealed by buildings and streets.

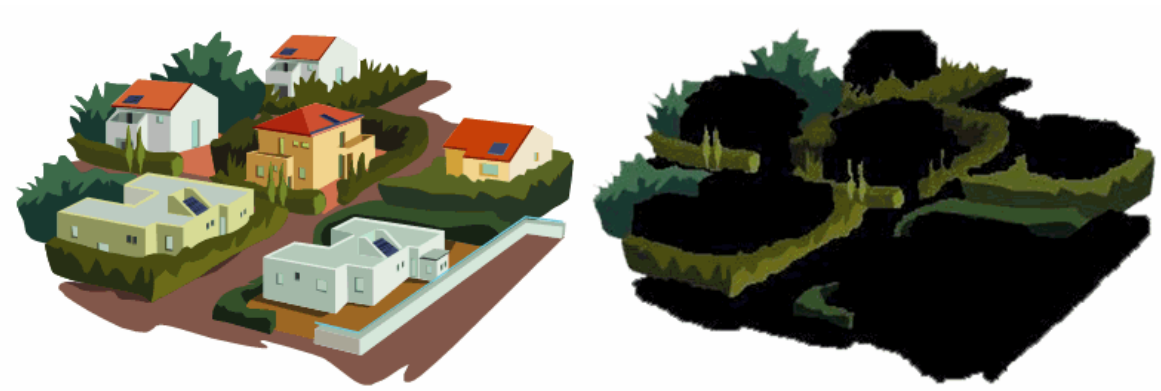

Fig. 1 Visualisation of the terms “settlement area” / "artificial surface" and “sealed soil”.
Source: Umweltbundesamt, 2010

Land take

Land take is also known as "urbanisation", "increase of artificial surfaces" and represents an increase of settlement areas (or artificial surfaces) over time, usually at the expanse of rural areas. This process can result in an increase of scattered settlements in rural regions or in an expansion of urban areas around an urban nucleus (urban sprawl). A clear distinction is usually difficult to make.

Land use intensity

Land use intensity refers to the amount of artificial surface per capita. Low land use intensity refers to a high amount of artificial surface per capita. Influencing factors for low land use intensities are above all the amount of second homes, the dominance of small disperse settlement structures and large touristic infrastructures. High land use intensity refers to a small amount of artificial surface per capita, being mainly the result of very compact settlement structures and high population density.

Urban sprawl

Urban sprawl is commonly used to describe physically expanding urban areas. The EEA has described sprawl as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural areas. Sprawl is the leading edge of urban growth and implies little planning control of land subdivision. Development is patchy, scattered and strung out, with a tendency for discontinuity. In Fig. 2 the growth of artificial surface in Munich between 1955 and 1990 is presented. Critics argue that sprawl has significant negative impacts, including high car dependence, higher per-person infrastructure costs, inefficient street layouts, low diversity of housing and business types, higher per-capita use of energy, land, and water, and last not least perceived low aesthetic value.

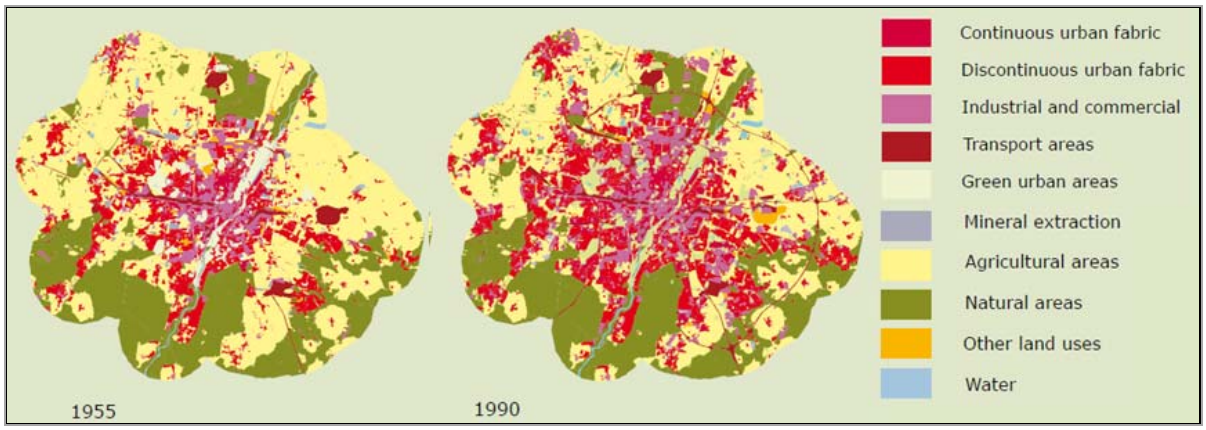

Fig. 2: Example for urban sprawl (Munich)
Source: EEA, 2006 [2]

Urbanisation of rural areas

This urbanisation process is not necessarily linked to an urban nucleus and is understood as an increase of scattered settlement patterns with low population density (dispersed urban development).

Brownfield redevelopment

Brownfields can be defined as land that has previously been developed, but which is not in current active use or is available for re-development. Recycling of Brownfields instead of developing Greenfield land outside the built environment reduces land take and further soil sealing. Some but not the majority of Brownfield sites are contaminated to differing extents and these require risk assessment.

1.2 The broader context of soil sealing

In order to explain the broader context of soil sealing the DPSIR[4] framework of the EEA is used, which is a common tool to explain environmental effects.

Driving forces. The need for new housing, business locations and road infrastructure can be defined as the key driving force for soil sealing. Most social and economic activities depend on the construction, maintenance and existence of sealed areas and developed land. Soil consumption has, however, considerable consequences for society and economy.

Pressures. The realisation of the above needs is usually realised outside or at the boarder of existing settlements. The process can be summarised as land take and creates artificial surface. New land take at the boarder of existing cities is described as sub-urbanisation. Urbanisation is understood as the conversion of rural areas into urban areas due to the increase of the road network, commercial facilities and housing. Urban sprawl is the combination of both.

State. Increasing land take (urban sprawl) creates more traffic, noise and sealed soil

Impacts. Through sealing and thus interrupting the exchange in between the soil system and other ecological compartments, including the biosphere, hydrosphere and atmosphere, all processes in the water cycle, biogeochemical cycles and energy transfers are affected. This leads to a number of negative effects:

- Less availability of fertile soils for future generations.
- Reduction of soil functions such as soil as sink and diluter for pollutants and transformation of organic wastes and a reduction of the water storage capacity that leads to ground water renewal.
- Loss of water retention areas and at the same time increase in surface water runoff, which leads to additional flood risk and in some cases to catastrophic floods.
- Less soil carbon sequestration and carbon storage.
- Landscape fragmentation and loss of biodiversity through reduction of habitats and remaining systems too small or too isolated to support species
- Unsustainable living patterns such as the increase of spread buildings leading to an increase in traffic and air emissions, infrastructure costs for the municipality concerned and urban development on high-quality agricultural land that leads to a lack of productive soils for food and other biomass production.
- Sealed surfaces have higher surface temperatures than green surfaces and alter the micro climate in particular in highly sealed urban areas. Large sealed areas become even more problematic in view of climate change and increasing temperatures [5] [5].

Responses. The process as described above can be interrupted by either reducing future land take or by implementing desealing measures. The second option is only rarely applied and very cost intensive. Reducing future land take can above all be realised by influencing planning policies and building rules,

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4 Driving Forces – Pressures – State – Impacts – Responses

5 Recent surface temperature surveys from the cities Budapest (Hungary) and Zaragoza (Spain) revealed that temperatures in highly sealed areas can be up to 20 °C higher compared to green shaded surfaces.

- by promoting the reuse of already developed land and Brownfields,
- by strengthening inner urban developments instead of urban sprawl, and
- by implementing building techniques which consume less soil or maintain some soil functions (in particular permeability).

These measures can be of binding or of voluntary nature.

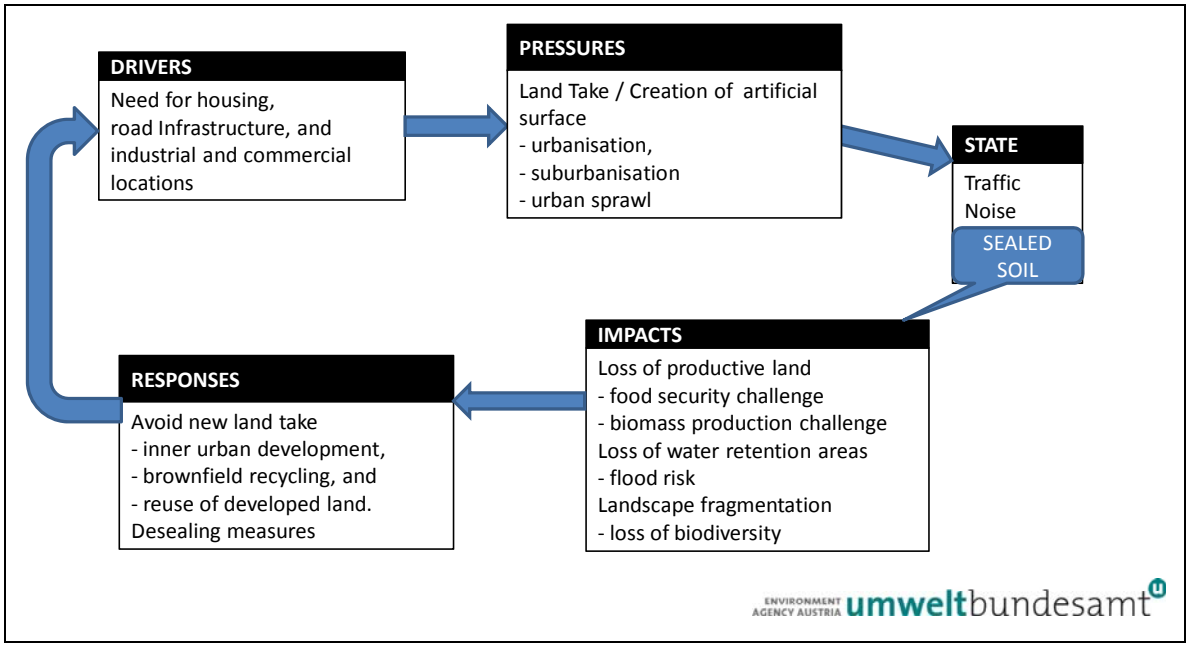

Fig. 3 Soil Sealing in the context of driving forces, negative effects and possible responses.
Source: Umweltbundesamt, 2010

1.3 Available data on artificial surface, sealing and land take

This report includes assessments with regard to artificial surfaces, land take and sealed surfaces in EU27. However, since available data sets have their limitations, some insights on data accuracy are provided. Tab. 1 provides an overview of available data, their source, geographical coverage, and time reference.

Tab. 1 Overview of data sources for the assessment of artificial surface, sealing and land take in EU 27.

	Artificial surfaces	Land take	Sealed surfaces
Source	CORINE Land Cover	CORINE Land Cover	EEA Soil Sealing Map of Europe
Time reference	1990, 2000, 2006	Comparison of the periods: 1990 – 2000 2000 - 2006	2006
Geo-graphical coverage	1990: EU27 without Cyprus, Finland, Malta, Sweden 2000: EU 27 2006: EU27 without Greece	Comparison of the periods: 1990 - 2000: EU 27 without Cyprus, Finland, Malta, Sweden 2000 – 2006: EU27 without	EU 27

and the UK Greece and the UK

Artificial surfaces and land take

The CORINE Land Cover[6] observations include the documentation of **artificial surfaces**, which refer to residential structures, industrial land use, infrastructure but also recreational land use types.

CORINE Land Cover data are generated by remote sensing technologies based on satellite images. The production of the European data layer is a shared approach between EEA and EEA member countries[7]. While the image production is centrally organised, the land cover mapping is done in the EEA member states to benefit from local knowledge. However, the interpretation of satellite images by national experts is a weak point with regard to comparability. In particular interpretation of artificial surfaces is very sensitive, since this land cover type includes very small and dispersed structures which are highly dependent on the mapping intensity of local experts.

CORINE Land Cover data sets for EU27 are available the years 1990, 2000 and 2006 but not for all Member States (see also Tab. 1).

- **CORINE 1990.** The first CORINE data set refers to the year 1990 but was in fact produced over a very long time span, ranging from 1985 to 1996. Besides that, the data set lacks a few countries which are today Members of the European Union, namely Cyprus, Finland, Malta and Sweden. In this report data referring to artificial surface in the year 1990 were corrected by data published by EEA in the report “Land Accounts for Europe 1990 - 2000”.
- **CORINE 2000.** The second CORINE data set refers to the year 2000 and is available for all EU Member States and was produced in shorter time ranging from 1998 to 2002.
- **CORINE 2006.** The most recent CORINE data set refers to the year 2006 and lacks data from Greece and the UK. In the case of the UK the data set is delayed. With regard to Greece no further information on the progress of the national data set is available.
- **Accuracy of CORINE land cover.** It has to be noted that CORINE Land Cover data provide only a rough indication of land use changes. The size of the minimum mapping unit is 25 hectares with a minimum width of 100 meters. Land cover changes of up to 5 ha are considered. This means that only major changes are mapped; a settlement extension of 10 additional family houses would for example not be considered. It can be concluded that CORINE land cover data on artificial surfaces underestimate the real situation by at least 5 % due to the rough resolution; in particular road networks and disperse settlement structures are neglected.
- **CORINE land cover and national data bases.** Many Member States monitor key land use classes based on real estate data bases. It has to be noted that such national inventories differ remarkably from the CORINE land cover observations. Main reasons are the fact that national data bases consider different land use classes and have a higher resolution. Such differences can amount to up to 50 %, as this is the case in Germany and France.

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6 Corine Land Cover (CLC) is a map of the European environmental landscape based on interpretation of satellite images. Corine stands for Coordination of Information on the Environment. It provides comparable digital maps of land cover for each country for much of Europe. Oberservations were carried out in 1990, 2000 and 2006. The European Environment Agency, and in particular European Topic Centre on Land Use and Spatial Information, are coordinating data production and analysis. http://etc-lusi.eionet.europa.eu/

7 EEA member countries are EU27 plus Switzerland, Norway, Iceland, Liechtenstein and Turkey.

Sealed surfaces

In 2009 the European Environment Agency published a specific Soil Sealing Map of Europe, which covers the whole European territory and has a higher resolution compared to the CORINE Land Cover data sets. The minimum mapping unit is 20 m x 20 m sealed surface within a pixel size of 100 m x 100 m. This layer was used to analyse the share of sealed surface per region and per region and capita.

1.3.1 The extent of artificial surfaces and sealed surfaces in 2006

According to the EEA soil sealing map 2.3 % of the European Union's territory were actually sealed in 2006, and 4.4 % of the territory were subject to artificial surface formation (Fig. 4). In the European Union artificial surfaces are on average sealed by 51 %, but this share varies strongly among Member States, depending on dominant settlement structures and the intensity of the interpretation of artificial surfaces.

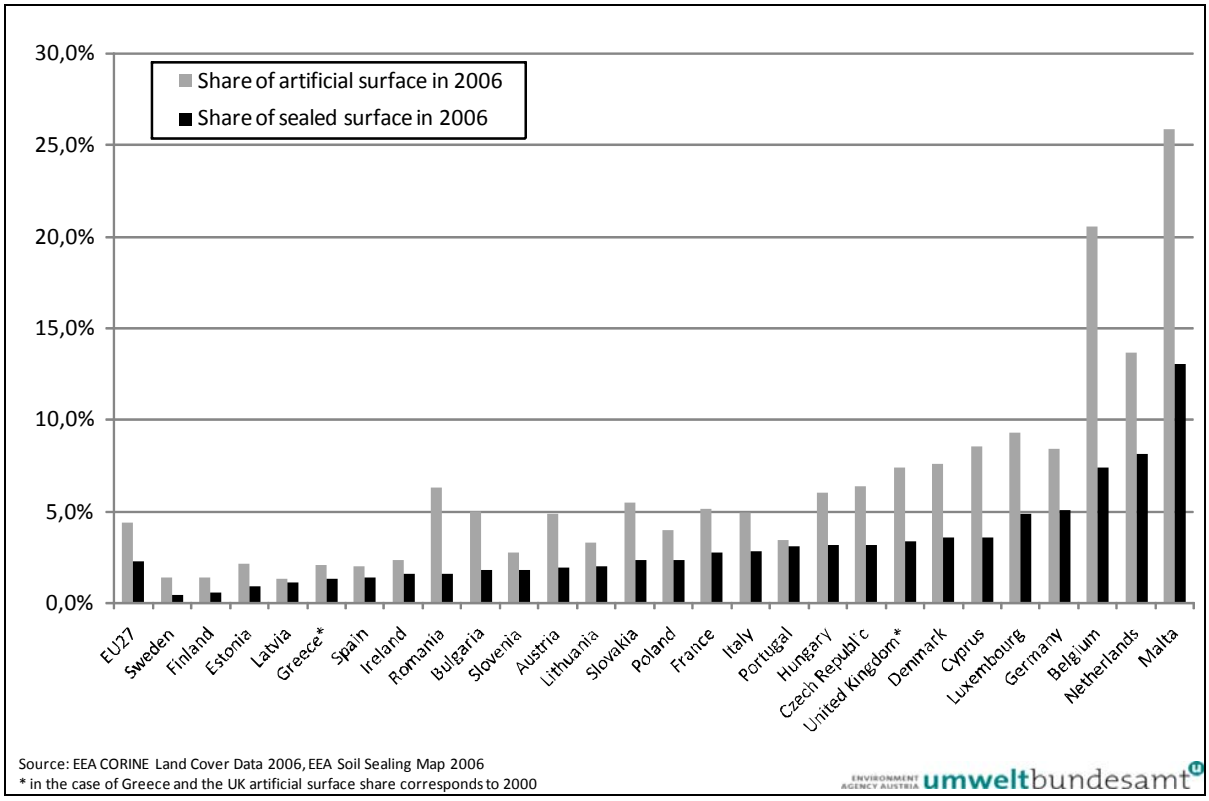

Fig. 4 Sealed surfaces and artificial surfaces in the EU Member States.

Source: CORINE Land Cover layer 2006, EEA soil sealing map 2006, [3], [4]

In a few countries this share is exceptionally high as this is the case in Portugal (90 %) and Latvia (83 %) where it can be assumed that the CORINE data set for artificial surfaces is rather incomplete.

- **Member States with strong land use pressures** (i.e. more than 8 % artificial surface) are above all Malta, the Netherlands, Belgium, Germany, Luxembourg, and Cyprus.

- **The highest sealing rates** can be observed in the same countries, namely Malta with 13 %, the Netherlands with 8 %, Belgium with 7.4 %, Germany and Luxembourg each with around 5 %, and Cyprus and Denmark, each with 3.6 %.

In the assessment related to Fig. 4 the actual size of Member States and their population densities are not considered. In Fig. 5 the amount of artificial surfaces and sealed surfaces per capita are presented, providing more insight on the actual land use intensity in the EU Member States. In 2006 EU citizens were on average stocked with 389 m² artificial surface and 200 m² sealed surface. Land use intensity is presented in increasing order from left to right for all EU Member States.

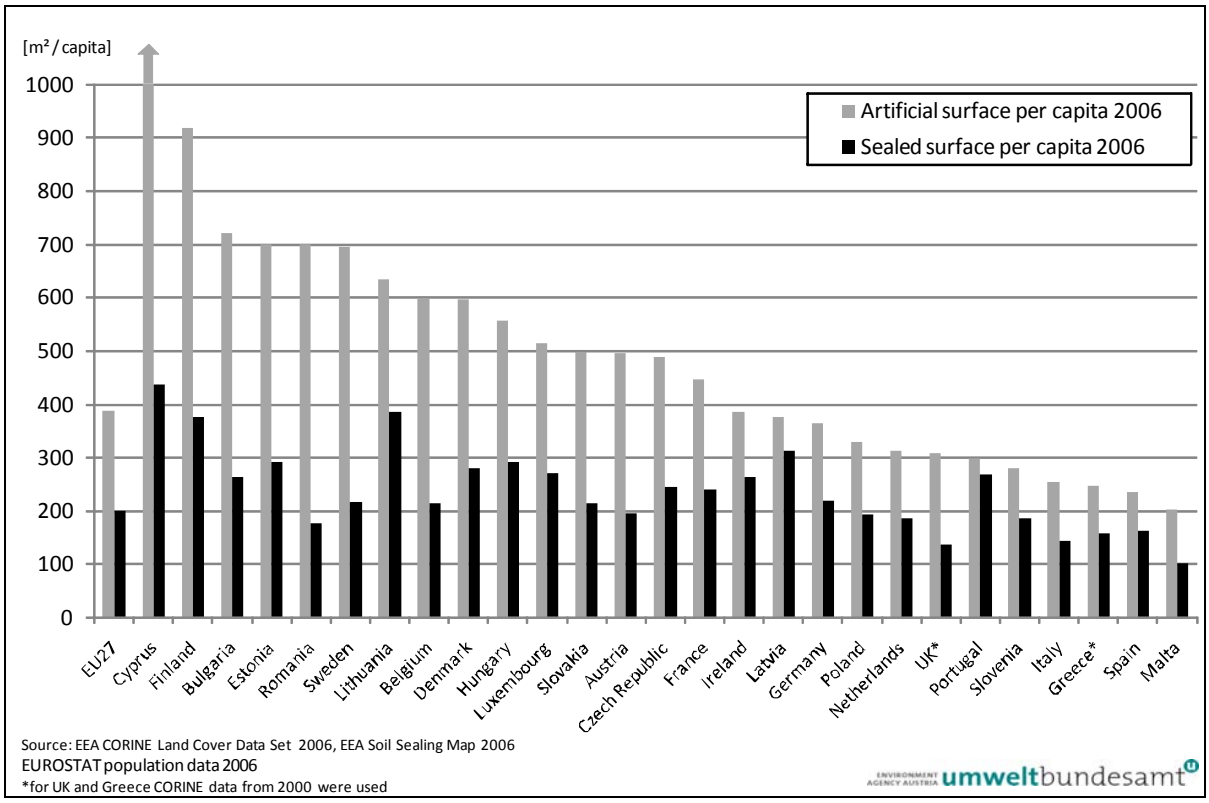

Fig. 5 Artificial surfaces and sealed surfaces per capita in EU 27.
Source: CORINE Land Cover layer 2006, EEA soil sealing map 2006, [3], [4]

- **Member States with low land use intensity** stand on the left side of Fig. 5. The lowest land use intensity can be observed in Cyprus with 1,032 m² artificial surface and 437 m² sealed surface per capita, followed by Finland and Bulgaria. Key influencing factors for low land use intensities are above all the amount of second homes, the dominance of small disperse settlement structures and large touristic infrastructures. Cyprus for instance provides touristic infrastructure for more than 2 million visitors per year. At the same time the country has only 770,000 inhabitants and a population density of 82 inhabitants per km². In Finland and Estonia disperse rural settlement structures are dominating and the share of second homes is very high. Bulgaria and Romania dispose of many active and abandoned open pit mining areas, which are catego-

rized as artificial surface. In the case of Bulgaria mining areas amount to 50 % of artificial surfaces[8], in the case of Romania a similar share can be assumed.

- **Member States with high land use intensity** stand on right side of Fig. 5 and are above all Malta, Spain, Greece, and Italy. High land use intensities occur if the majority of inhabitants lives in large urban agglomerations. Malta can be considered as one urban agglomeration with an average population density of 1.282 capita per km². About 80 % of the Spanish population lives in urban areas and 40 % in large cities with more than 100,000 inhabitants. Urban population of Italy and Greece are above 60 % and the share of people living in large cities with more than 100,000 inhabitants is at 41 % in Greece and 23 % in Italy.

1.3.2 Changes in land use intensity between 1990 and 2006

Changes of land use intensities over time indicate positive or negative land use trends. Decoupling the growth of population and artificial surface is a key target for sustainable development, the principle is visualised in Fig. 6.

- **Negative trends.** In the European Union the overall demand for artificial surface per inhabitant increased between 1990 and 2006. However, a stagnation of this trend can be observed after the turn of the century:

  Between 1990 and 2000 the amount of artificial surface per inhabitant increased in all Member States except Austria, France, Luxembourg, and the UK. The highest increases can be observed in Estonia (+111 m²), Ireland (+68 m²), Bulgaria (+48 m²), and Portugal (+45 m²).

  It has to be noted that in the case of Estonia and Bulgaria the rapid growth of this index was mainly caused by major population losses (Estonia -12.6 % and Bulgaria -6.6 %). In the case of Ireland and Portugal the rapid growth of the index “artificial surface per capita” was induced by a general building boom, an increase in living standards and the realisation of major infrastructure projects.

  Between 2000 and 2006 in several new Member States the index “artificial surface per capita” continues to increase due to major population losses, this is the case in Bulgaria, Estonia, Romania, Lithuania, Hungary, and Latvia. In Spain, Portugal and the Netherlands an increasing demand for artificial surface per capita can be observed referring to a lasting building boom.

8 JRC (2004): PECOMINES, Mining, mining waste and related environmental issues: problems and solutions in Central and Eastern European Candidate Countries, eds: G. Jordan and D’ Alessandro M., ISBN 92-894-4935-7

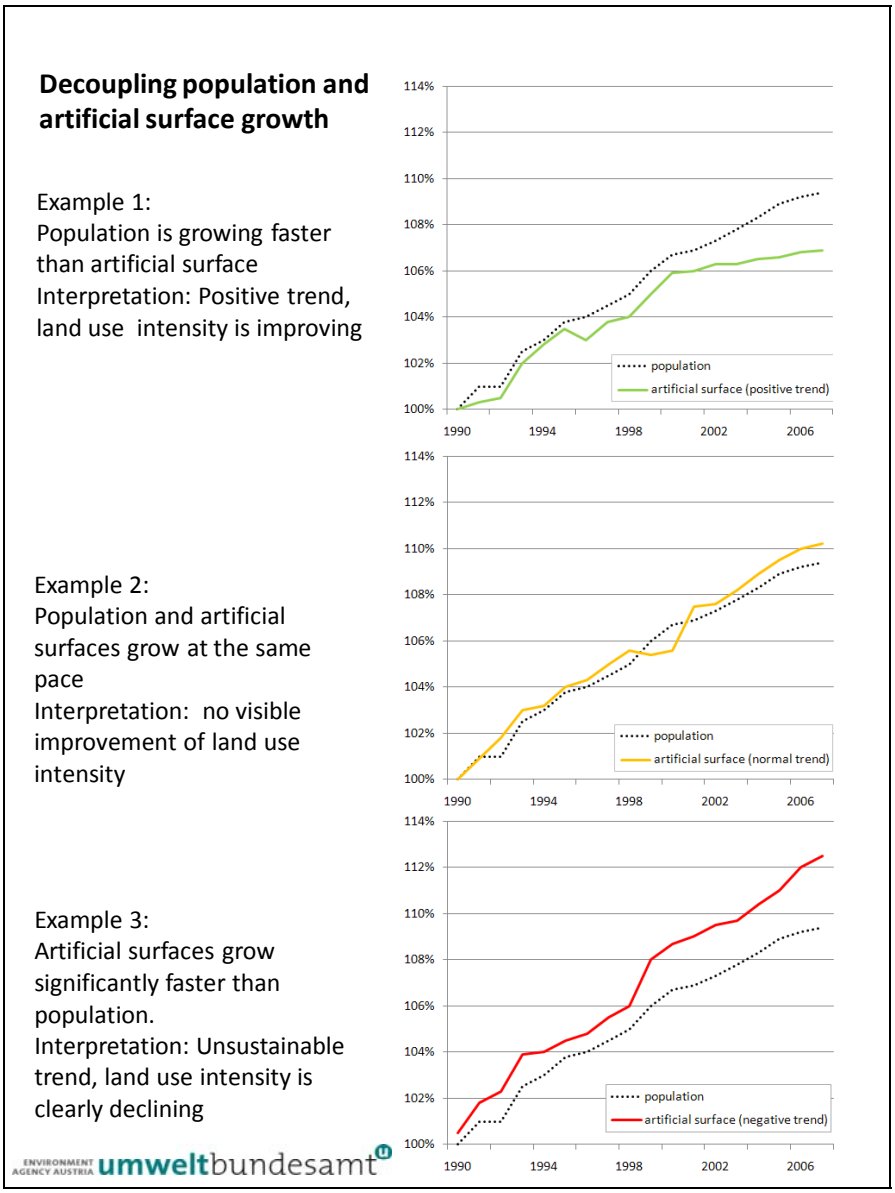

Fig. 6 The principle of decoupling growth of population and artificial surfaces.
Source: Umweltbundesamt, 2010

- **Positive trends.** In a few cases land use intensity improved between 1990 and 2006, as this was the case for Luxembourg, Belgium, France, Malta, UK and Austria (see Fig. 7). This can be reasoned with the fact that population was growing faster than artificial surface and appropriate policy measures to reduce land take were implemented, or with a saturation of the development of major infrastructure projects, or simply with extreme population growth as for example in the case of Luxembourg +23.7 % or Malta +14.9 %.

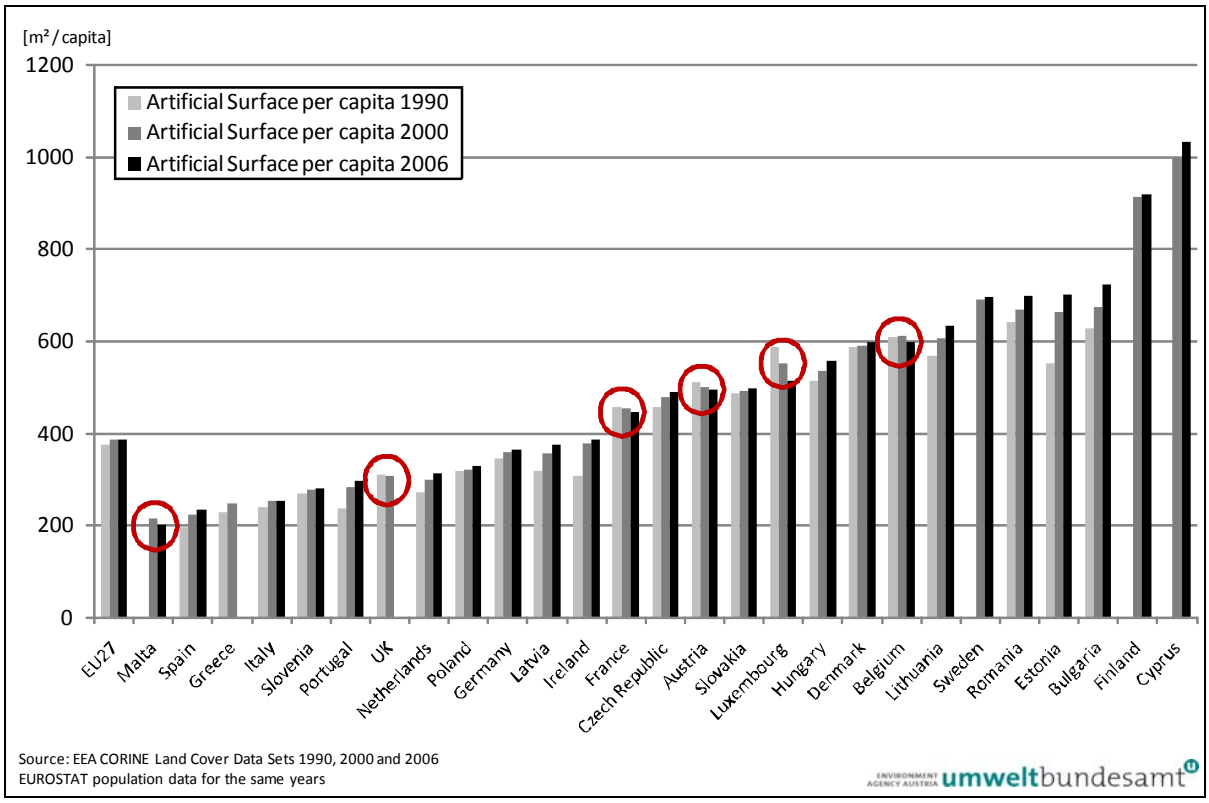

Fig. 7 Changes in land use intensity in EU 27 between 1990 and 2006.

Source: EUROSTAT, CORINE Land Cover, [3]
Note: assessment incomplete for 1990 (CY, FI, MT, SE) and 2006 (GR, UK).

1.3.3 Annual land take before and after 2000

Land take is defined as increase of artificial surfaces (or settlement area) over time. In Tab. 2 two periods are compared, firstly the period 1990 to 2000, and secondly the period 2000 to 2006. For both periods new artificial surface per year was derived and the resulting growth rate calculated.

Since land take is highly dependent on population growth this aspect was also considered. The average annual land take of a specific country was related to the number of inhabitants in that period. For this index the growth rate was equally derived.

As to the territory of EU27 a slight decrease of average annual land take can be observed, both in terms of new artificial surface per year and also in relation to the number of inhabitants. Average annual land take decreased from 100,640 hectares in the period 1990 – 2000 to 92,016 hectares in the period 2000 to 2006, meaning a decrease of 9 percent. Taking population growth into account this means that per EU citizen the average land consumption slightly fell from 2.1 m² per year to 1.9 m².

- **Clear decrease of annual land take.** In the case of Belgium, the Czech Republic, Germany, Luxembourg, Poland, and Slovakia significant decreases of annual land take with more than 25 % decrease can be observed (dark green rows in Tab. 2). More moderate decreases with less than 25 % are visible in Ireland, Italy, Latvia, the Netherlands, and Portugal (light green rows in Tab. 2). With regard to annual land take per capita the most outstanding decreases were reached in Belgium, Germany, and Luxembourg. Reasons for these trends are for example the slowing down of building booms as this was the case in Ireland and Portugal, or countries with strong land use pressures, where the amount of artificial surface is already very high and where the development of new land is either geographically limited or by means of planning restrictions (i.e. Luxembourg, Belgium, Germany).
- **Clear increase of annual land take.** In all other Member States average annual land take was clearly higher after the turn of the century. This is the case in most new Member States, namely Bulgaria, Estonia, Latvia, Lithuania, Hungary, Slovenia, and Romania. In all these countries growth of annual land take per capita is even higher since these countries (except Slovenia) were heavily affected by shrinking population whereas at the same time major infrastructure projects were realised. Besides that, clear increases of annual land take can also be observed in Austria, Denmark and Spain. This can be explained with a sustained growth of the building sector and at the same time lack of planning restrictions.
- **Land take per capita.** In the period 2000 to 2006 the highest values for land take per capita can be observed in Cyprus, Ireland and Spain. In the case of Cyprus this phenomenon can be assigned to the realisation of large touristic infrastructure, in the case of Spain and Ireland to a sustained building boom.

Tab. 2 Mean annual land take per before and after 2000.

Source: CORINE Land Cover layers 1990, 2000, 2006 [3] and EUROSTAT population data
Note: assessment incomplete for Cyprus, Finland, Malta, and Sweden (1990 CORINE data missing) and UK and Greece (2006 CORINE data missing).
Values for EU27 are based on best estimates for the missing countries.

	annual land take			annual land take per capita		
	1990-2000 [hectare]	2000-2006 [hectare]	growth [%]	1990-2000 [m²/cap]	2000–2006 [m²/cap]	growth [%]
Austria	845	1,296	53%	1.1	1.6	48%
Belgium	2,211	459	-79%	2.2	0.4	-80%
Bulgaria	357	691	93%	0.4	0.9	106%
Cyprus		1,706		0.0	23.4	
Czech Rep.	2,042	1,446	-29%	2.0	1.4	-29%
Denmark	1,379	1,582	15%	2.6	2.9	12%
Estonia	435	537	23%	3.0	4.0	34%
Finland		1,865			3.6	
France	15,612	13,714	-12%	2.7	2.2	-17%
Germany	22,016	7,957	-64%	2.7	1.0	-65%
Greece	3,848			3.7		
Hungary	1,409	2,481	76%	1.4	2.4	79%
Ireland	3,410	3,342	-2%	9.4	8.4	-11%
Italy	8,724	8,049	-8%	1.5	1.4	-9%
Latvia	23	164	612%	0.1	0.7	669%
Lithuania	287	472	64%	0.8	1.4	71%
Luxembourg	170	28	-84%	4.2	0.6	-85%
Malta		1			<0.1	
Netherlands	6,834	5,975	-13%	4.4	3.7	-16%
Poland	3,167	1,867	-41%	0.8	0.5	-41%
Portugal	5,039	4,589	-9%	5.0	4.4	-11%
Romania	1,218	1,515	24%	0.5	0.7	29%
Slovakia	762	519	-32%	1.4	1.0	-33%
Slovenia	136	177	30%	0.7	0.9	30%
Spain	13,425	22,885	70%	3.4	5.5	60%
Sweden		2,924			3.3	
UK	4,190			0.7		
EU 27	**100,640**	**92,016**	**-9%**	**2.1**	**1.9**	**-10%**

1.3.4 Rapidly growing countries and regions

The Member State level. In the period 2000 to 2006 the average increase in artificial surface amounted to 2.8 % in the EU 27. Highest increases of artificial surfaces, with more than 10 % can be observed in Spain, Cyprus, Ireland, and Portugal and the lowest in Malta, Belgium, Romania and Luxembourg (Fig. 8). However, this information ignores the development of population and regional disparities and does not provide any information on the already existing amount of artificial surface before 2000. For example countries with the highest growth rates of artificial surfaces (Spain, Cyprus, and Ireland) were at the same time subject to high population increase. Despite rapid growth of artificial surfaces their total shares of artificial surfaces were still among the lowest compared to other Member States. On the other hand countries with very small growth rates like Malta, Belgium and Luxembourg already had high shares of artificial surfaces before 2000 (compare with Fig. 8).

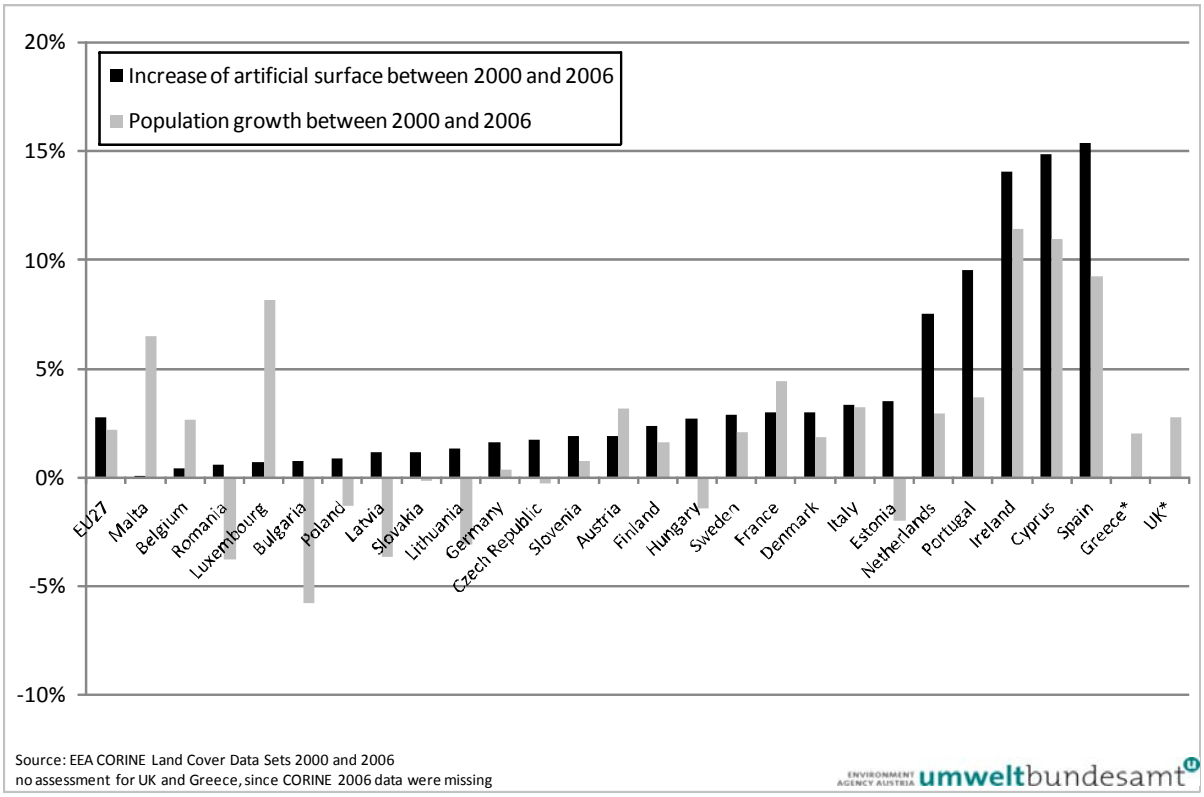

Fig. 8 EU27: Growth of artificial surfaces and population between 2000 and 2006.

Source: CORINE Land Cover layers 2000, 2006, [3]
Note: assessment incomplete for Cyprus, Finland, Malta, and Sweden (1990 CORINE data missing) and UK and Greece (2006 CORINE data missing).

At the regional level it can be observed that apart from the above mentioned countries (Spain, Portugal, Ireland, Cyprus), several individual regions were also affected by high increases of artificial surface, among them half of the Dutch regions, eight provinces in Italy (Vercelli, Lodi, Verona, Piacenza, Parma, Campobasso, Matera, Catanzaro), three French départements (Vendée, Tarn-et-Garonne, Corrèze), the Poznan region in Poland, West Sty-

ria in Austria, the Põhja-Eesti region in Estonia, and the Jugovzhodna region in Slovenia (see Fig. 9).

However, analysing land take in relation to the actual state of soil sealing provides more insight than assessing land take alone. In order to facilitate this comparison two regional assessments are presented next to each other, namely Fig. 8 indicating land take in the EU regions in the period 2000 and 2006 and Fig. 10 providing an overview regarding the extent of sealed surface in the EU regions in 2006. The comparison reveals that despite rapid land take most regions still have very low sealing rates. Only very few regions are affected by rapid land take and at the same time high sealing rates. This phenomenon can be observed along the Portuguese coast, in the Netherlands, in Northern Italy, in Germany along the Dutch boarder, and in the West of Denmark close to the Swedish boarder (Sjaelland).

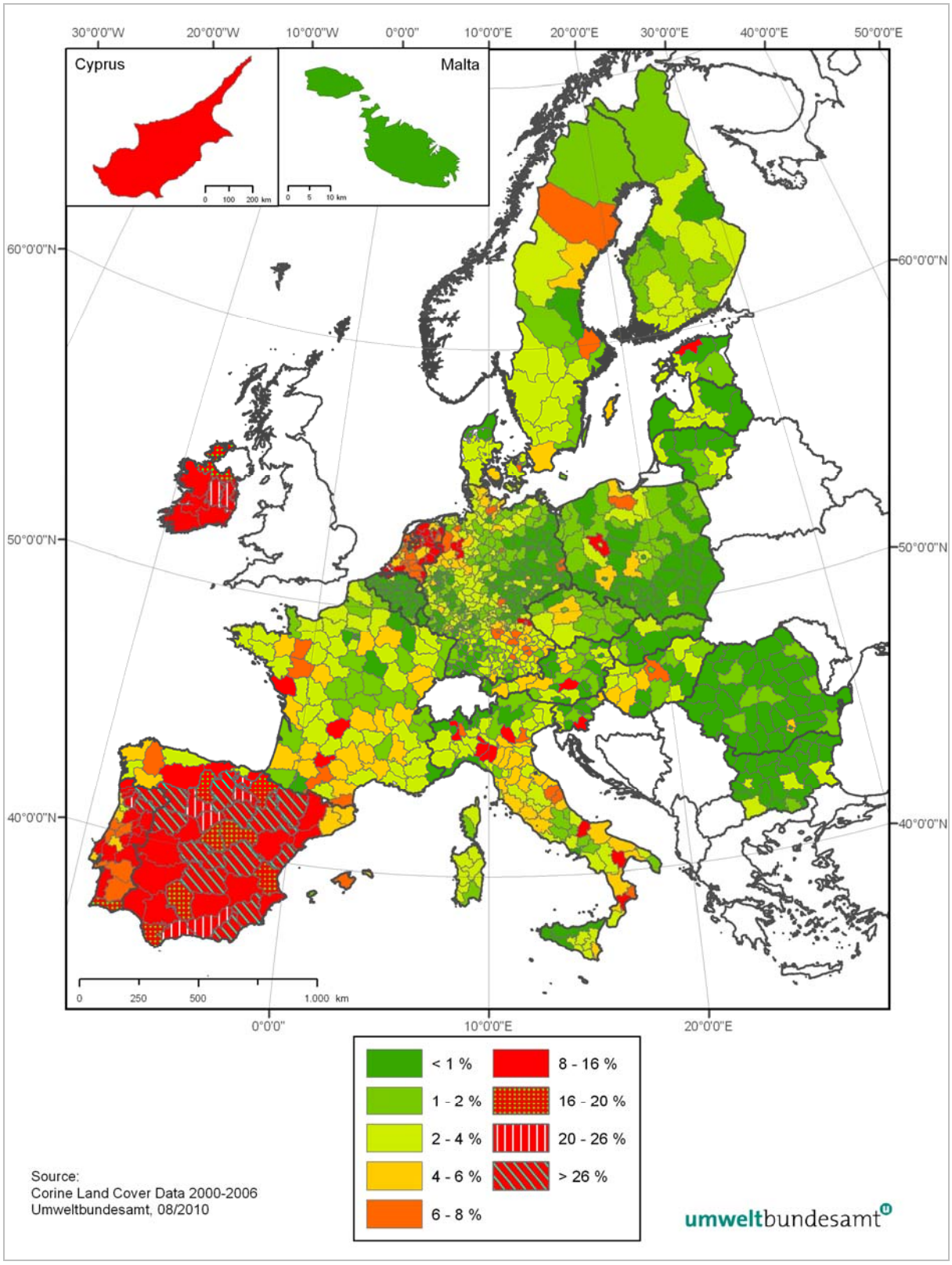

Fig. 9 EU27: Increase in artificial surface per region (NUTS-3), 2000 - 2006.

Source: CORINE Land Cover 2000 and 2006, [3]

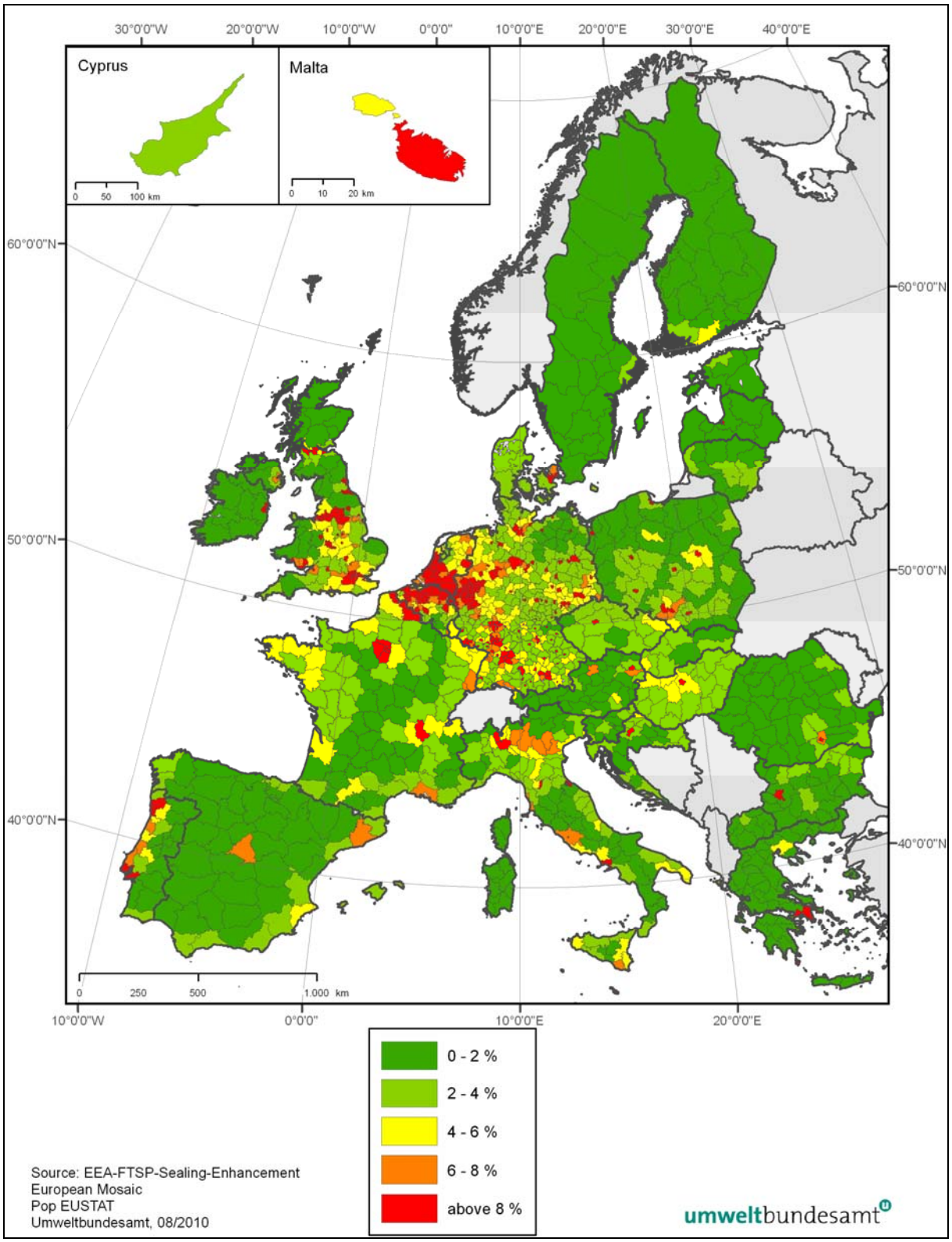

Fig. 10 EU27: Share of sealed surface per region (NUTS3)
Source: EEA soil sealing map 2006, [4]

1.3.5 Summary

Data situation. At the time of producing the report the best available data set was the EEA[9] soil sealing map referring to the year 2006. The data set has a minimum sensitivity of 20 m x 20 m sealed surface, corresponding to the size of two adjacent tennis courts or the size of a parking area for 25 – 30 cars. Farther reaching data – with lower resolution – can be obtained from the CORINE Land Cover data sets, which exist for the years 1990, 2000, and 2006 and which include the category "artificial surface". This category considers housing, commercial sites, road networks and extraction sites. It has to be noted that CORINE Land Cover data provide only a rough indication of land use changes. In the CORINE assessment land use changes need to have of a minimum size of 5 hectares and a minimum width of 100 m. This means that only major changes are mapped; a settlement extension of 10 additional family houses would for example not be considered. The actual land take is therefore higher than presented by the CORINE assessment.

Extent of artificial surfaces and soil sealing. 4.4. % of the European Union's territory is classified as artificial surface, while 2.3 % is actually sealed. The relation between sealed and artificial surfaces is on average 51 %, but is subject to great variations among the Member States, ranging from 25 % in Romania to 90 % in Portugal. Reasons for these variations are on the one hand variations of the dominant settlement structures (small dispersed settlements versus large compact cities) but on the other hand also the inaccuracy of the CORINE data set for artificial surfaces which underestimates the real situation.

Member States with the highest sealing rates are above all Malta with 13 %, the Netherlands with 8 %, Belgium with 7.4 %, Germany and Luxembourg each with around 5 %, and Cyprus and Denmark, each with 3.6 %

Land take. Between 1990 and 2006 a slight decrease of annual land take can be observed from 100,640 hectares in the period 1990 – 2000 to 92,016 hectares in the period 2000 to 2006, corresponding to a decrease of 9 percent. In Belgium, the Czech Republic, Germany, Luxembourg, Poland, and Slovakia significant decreases of annual land take with more than 25 % decrease can be observed and more moderate decreases with less than 25 % are visible in Ireland, Italy, Latvia, the Netherlands, and Portugal. In all other Member States average annual land take clearly increased after the turn of the century.

Land use intensity. For each EU citizen 389 m² artificial surfaces are available in 2006, which is 15 m² more compared to 1990. The demand for artificial surface per capita is increasing in most Member States. In a few cases land use intensity improves after 2000 as this is the case in Luxembourg, Belgium, France, Malta, UK and Austria. This can be reasoned with the fact that population was growing faster than artificial surface and appropriate policy measures to reduce land take were implemented.

Rapidly growing countries and regions. Since the turn of the century the amount of artificial surfaces increased by 3 % within the territory of EU27. Exceptionally high increases with more than 6 % can be observed in the Netherlands, Portugal, Ireland, Cyprus, and Spain. Several European regions are also affected by a rapid increase of artificial surface, among them half of the Dutch regions, eight provinces in Italy (Vercelli, Lodi, Verona, Piacenza, Parma, Campobasso, Matera, Catanzaro), three French départements (Vendée, Tarn-et-Garonne, Corrèze), the Poznan region in Poland, West Styria in Austria, the Põhja-Eesti region in Estonia, and the Jugovzhodna region in Slovenia.

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9 Based on the same satellite images used for the CORINE 2006 data set.

2 OVERVIEW OF EXISTING POLICIES TO REDUCE AND MITIGATE SOIL SEALING IN THE EU AND MEMBER STATES

2.1 Relevant policy at EU level (short outline)

EU policy directly addressing soil sealing. The most noteworthy EU policy documents with regard to soil protection and the prevention of soil sealing are the Soil Thematic Strategy and the draft Soil Framework Directive.

- Thematic Strategy for Soil Protection (COM(2006)231, 22.9.2006). The strategy sets out the model for the European approach to soil for the European Commission. This includes identifying key threats to soil quality, actions to ensure a high level of soil protection, overall objectives and measures to be taken. Sealing is identified as among the key threats and degradation processes on European soils. The dissemination of examples of best practice for limiting soil sealing and inappropriate urban expansion is part of the strategy.
- Proposal for a Soil Framework Directive (COM(2006) 232, 22.9.2006). The objective of the draft Directive, part of the strategy mentioned above, is to provide a framework that will enable each Member State to decide how best to protect and use soil in their territory in a sustainable way. It will essentially require Member States to identify areas at risk of soil degradation and to take measures to address those risks.

  With regard to soil sealing the following principles were defined: “For the purposes of preserving the soil functions …Member States shall take appropriate measures to limit sealing or, where sealing is to be carried out, to mitigate its effects in particular by the use of construction techniques and products which will allow as many of those functions as possible to be maintained.” (Article 5)

  The European Parliament has adopted its first reading on the proposed Directive in November 2007. The Environment Council has not yet been able to reach an agreement due to the opposition of some Member States forming a blocking minority.

EU policy programmes influencing soil sealing. Several EU policy programmes include a targeted approach towards efficient soil use and the reduction of soil sealing. However, they have an indicative character and do not include binding policy targets.

- Thematic Strategy on the Urban Environment (COM(2005)718). The Strategy’s aim is to map and concentrate EU action on urban environment issues, focusing on synergies between other EU policies. There is limited reference to sustainable urban design via appropriate land use planning, helping to reduce urban sprawl, loss of natural habitats and biodiversity. It is commented that integrated management of the urban environment should foster sustainable land-use policies which avoid urban sprawl and reduce soil-sealing.

- European Spatial Development Perspective (ESDP)[10]. The ESDP is an informal EU policy developed under Germany's Presidency. An informal Council of Ministers was held focusing upon spatial planning which lead to the ESDP, setting out a strategic approach to spatial development policies aimed at moving towards a balanced and sustainable development of the territory of the European Union. The dossier does highlight the need to protect Europe's soils, but focuses primarily on contamination, pollution and erosion issues [6].
- Territorial Agenda of the European Union (TAEU)[11]. The TAEU is also an informal EU policy measure. The TAEU's focus is primarily upon territorial cohesion issues, making the best use of territorial diversity and identifying development opportunities. Soil and its sealing is not specifically highlighted. The TAEU's main role in this context is to highlighting the importance of spatial issues in the EU and the role of the urban environment

EU Directives. Several EU directives have the aim to protect natural resources such as water, biodiversity or the availability of productive land. Some of them include measures to avoid building activities in sensible areas. Among these the following were found to be relevant:

- The Water Framework Directive. Through the use of river basin management planning account has to be taken of the quantity of water available in the catchment and as such sealing is of relevance.
- The Flood Risk Management Directive. Emphasis on the development of plans to limit flood risk is taken which includes consideration of runoff and the impacts of sealing.
- The Environmental Impact Assessment Directive. In the planning phase of large construction projects all impacts on affected environmental resources have to be taken into account and limited as far as possible. Soil functionality is vital to other environmental services so this should be assessed to avoid inappropriate sealing.
- The Strategic Environmental Assessment Directive. Requires plans and programmes to be assessed for their environmental impacts. At this level it is possible to divert e.g. urban development away from high value soils in order to reuse already developed sites.
- The Habitats and Birds Directives. Both require the establishment of protected areas, in order to protect certain species and the habitats they require. In doing so the soils are protected to keep them as vital habitats and as such limits sealing of the landscape.

EU funding mechanisms. EU funding schemes have the reputation to rigorously support soil consumption. However, new developments in the funding scheme of the EU Structural Funds give reason to hope, since sustainable use of natural resources is more and more given priority (see also JESSICA funds on p 198)

The Trans European Transport Network (TEN-T). The TENT-T Programme promotes the construction of transport infrastructure in Europe. Grants are given for studies as well as di-

10 European Commission - Committee on Spatial Development (1999): ESDP - European Spatial Development Perspective

11 Heads of the European Union Member States (2007): Territorial Agenda of the European Union: Towards a More Competitive and Sustainable Europe of Diverse Regions – Agreed at the occasion of the Informal Ministerial Meeting on Urban Development and Territorial Cohesion on 24 / 25 May 2007

rect funds for infrastructure projects and support to pay interests.

The EU Structural and Cohesion Funds. Structural Funds allow the European Union to grant financial assistance to resolve structural economic and social problems. This supports improved urban development which could have negative impacts if this leads to urban expansion or more intense development. At the beginning of the century the Structural Funds initiated new funding schemes with special focus on sustainable investments. Among these the JESSICA funds is most noteworthy, since the funds is dedicated to urban renewal and the promotion of social housing. By the end of 2010 about 1.7 billion Euros were allocated to the JESSICA funds.

The European Investment Bank. The bank offers grants for urban renewal and development of infrastructure which could lead to increased sealing.

2.2 Austria

Geography. Alpine landscapes are dominant in Austria; two thirds of the national territory is under permanent risk of natural hazards like floods, land slides, and avalanches. The remaining territory (37 %) is under high pressure of competing land uses. In the Western provinces permanent settlements are reduced to a few valleys where land use is extremely intense fulfilling the needs of touristic infrastructure, industry, and those of a growing population with increasing standards of living.

Demography. Between 1990 and 2006 Austria's population is grew by 4.4 % which is almost twice as much as the EU average. However, growth is restricted to few hot spot areas. Between 1991 and 2001 all urban centres were subject to massive suburbanization with declining population in the city centres[12]. In the same time the majority of rural regions suffered from shrinking population and loss of infrastructure (in many of which land take was still considerable). The average settlement area per capita increased by 160 % between 1950 and 2007 from 200 to 520 m² per capita - whereas in the same period Austria's population grew by 20% - from 6.9 to 8.3 million inhabitants (see Fig. 12). The increase mainly occurred at the expense of arable land and pastures.

2.2.1 Land take and sealing

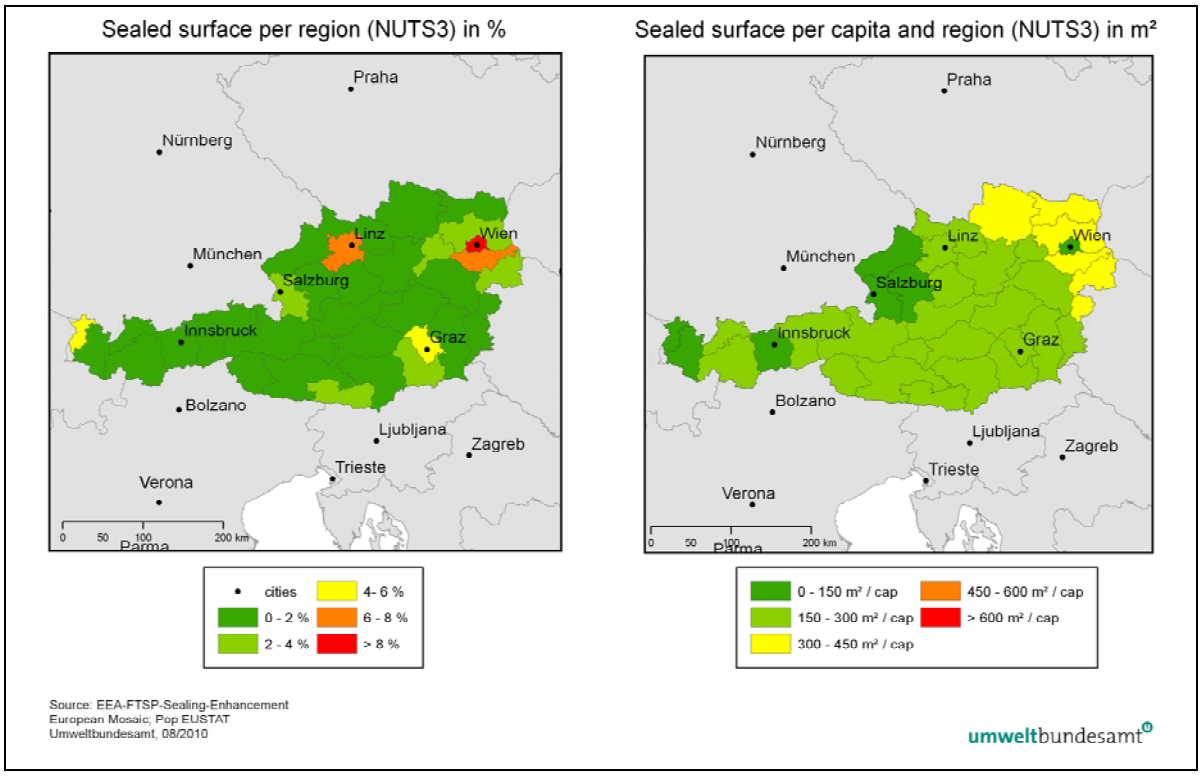

Fig. 11 Austria: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Hot spots of urban sprawl and soil sealing are the Vienna agglomeration, Linz, Graz and the Inn valley in Tyrol. Inefficient land use is in particular visible in the regions around Vienna, which are highly affected by urban sprawl and low urban densities. In this region the sealed

12 ÖROK Atlas; http://www.oerok.at

surface is on average above 300 m² per capita (see Fig. 11).

Comparison with other EU Member States. Austria's inhabitants dispose on average of 496 m² artificial surface, which is 23 % above the EU average. In the period 2000 to 2006 the growth of artificial surface did not exceed population growth. A closer look at the situation reveals that in 2009 already 15 % of the possible residential space (which is only one third of the territory as mentioned above) was covered with buildings and transport infrastructure and 6 % was sealed.

Since 2002 soil sealing and land take are being monitored by the Austrian Environment Agency based on data of the Federal Agency for Surveying and Mapping (BEV)[13]. The development of new sealing per year is a defined national sustainability indicator [14] [7].

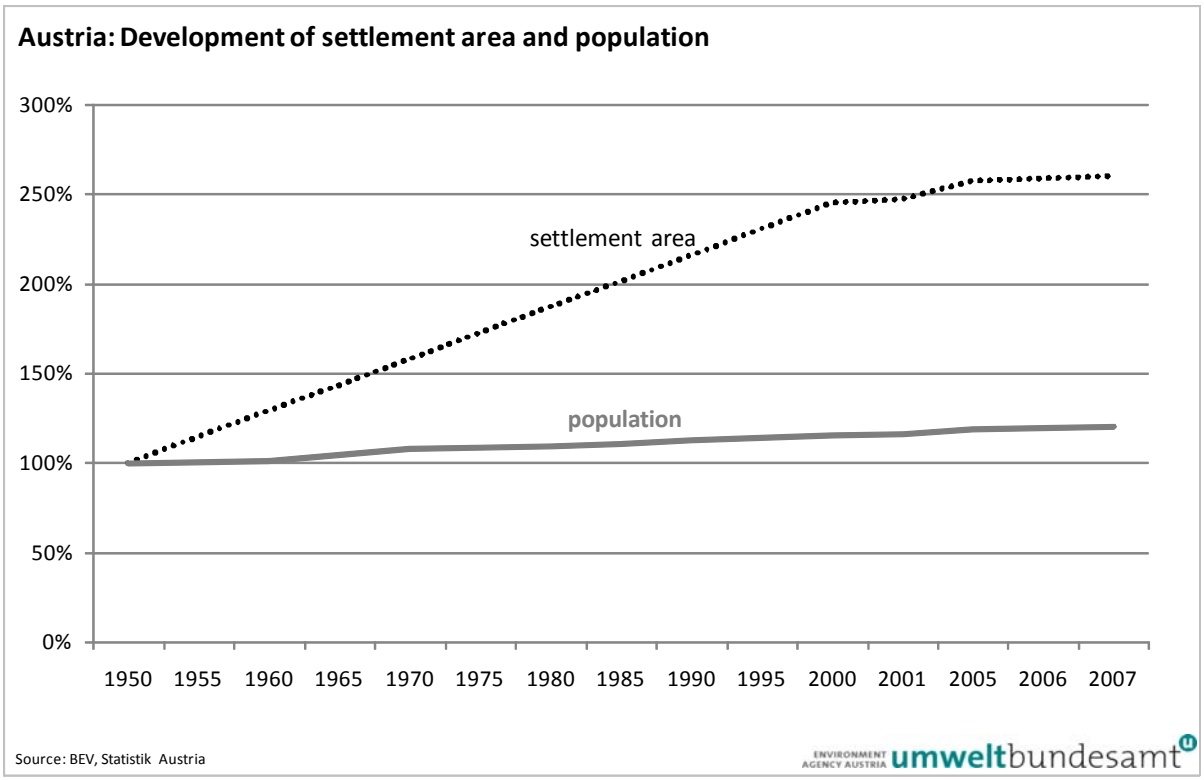

Fig. 12 Development of settlement area and population between 1950 and 2009

Source: Federal Ministry of Agriculture, Forestry, Environment and Water Management [8]

2.2.2 Policies of interest

Reduction of urban sprawl, land take and soil sealing are part of a complex regulatory framework on spatial planning. Spatial planning follows a strong federal structure. At the national level Concepts for Spatial Development (ÖREK) are published on a regular basis (usually 10 years); they have an indicative character [9]. ÖREK documents refer to spatial planning priorities for the near future. Spatial planning is legislated at the level of the Federal

13 BEV Bundesamt für Eich- und Vermessungswesen (Federal Agency for Surveying and Mapping), soil sealing is derived as 32 % of the land take
Umweltbundesamt (2009): http://www.umweltbundesamt.at/umweltschutz/raumordnung/flaechenverbrauch/

14 Headline indicator BO1a „hectare of sealed surface" published in [39]

Provinces. The nine Austrian provinces dispose of their own spatial planning laws which are regularly adopted and reflect the recommendations of the actual ÖREK document. Final planning decisions are made at the municipality level under the supervision of the provincial governments.

Soil sealing target. In 2002 the Austrian Strategy for Sustainable Development declared "*until 2010 the increase of annually sealed soil shall be reduced to one tenth of its initial value*" [10], In 2002 the annual rate for soil sealing amounted to 9 hectares per day, most recent data refer to 5 hectares per day, the target defines a sealing rate below 1 hectare per day. Overall objective of this policy target was to stop the increasing fragmentation of landscapes and to conserve soil functions as far as possible. Since then soil sealing is being monitored and published every two years in the Report on Monitoring Sustainable Development [7].

The Strategy recommends enhancing inner urban development, to increase the efficiency of land use and the quality of living in small cities, to allow new land developments only along top public transport lines, to encourage Brownfield sites, and protect landscapes and recreational areas. All Austrian provinces have recently adopted their spatial planning regulations, efficient land use is a priority and new instruments are available to allow reduction of land take.

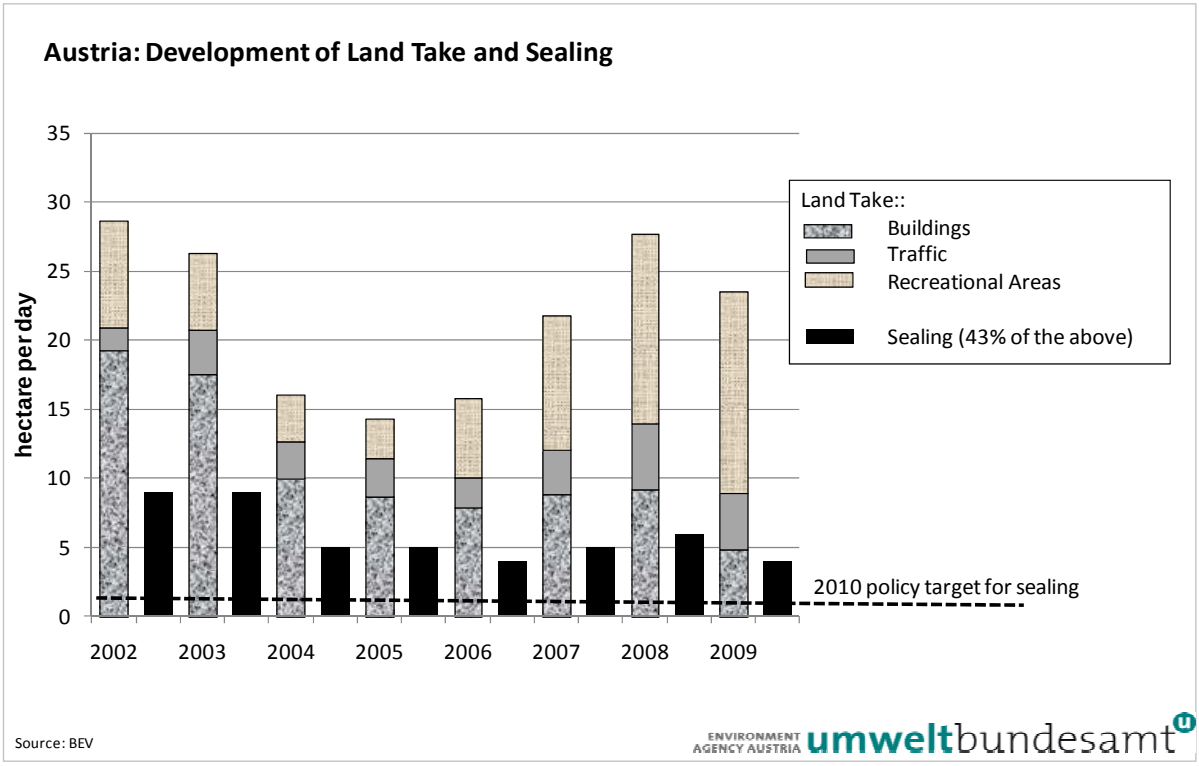

Fig. 13 Austria: Development of Land Take and Sealing between 2002 and 2009

Source: Federal Ministry of Agriculture, Forestry, Environment & Water Management [11]

Reduction of urban sprawl. Despite the fact that daily sealing rates are decreasing since 2002, Austria did not reach the policy target for 2010. A positive trend can be observed regarding the land take for building plots. The Austrian provinces have initiated several measures of various natures which are expected to have more impact on the reduction of land

take and sealing in the future, specific milestones were:

- New spatial planning regulations to improve land use efficiency. Since publication of the last Spatial Development Concept in 2001 all provinces have implemented measures in their spatial planning laws to improve land use efficiency.
- *1/ Building permits with expiration date*. About 30 % of land with a building permit is still undeveloped. Land with a building permit is considered as a good long term investment and owners have in many cases no intention to actually use their land. This phenomenon has led to enormous urban sprawl. The annual amount of green land being converted into building plots is still considerable with on average 5 to 10 hectares per day or 2 – 4 m² per inhabitant and year. As a consequence the provinces have adopted their spatial planning laws accordingly. New building permits usually expire after 5 years. This means that building permits are withdrawn if the owner has not started to build after five years. This instrument proved to be very efficient for recently acquired building plots. However, there are still numerous building plots with old permits, where this tool cannot be implemented.
- *2/ Contracts between municipalities and land owners.* Seven out of nine provinces have recently introduced this tool in their spatial planning laws. If municipalities sell building land they can arrange a contract with the land owner, defining the future use, the time frame for the realization of the planned development, but also refunding or pre-financing of costs related to the provision of new infrastructure (new streets, canalization, power lines, water supply etc.). This tool gives municipalities the opportunity to make sure that land for building is efficiently used.
- *3/ Real estate funds at provincial level.* Five out of nine provinces have their own real estate funds. The provinces provide low interest loans to municipalities primarily for the acquisition of real estates that are of strategic importance and shall be used for public purposes (schools, kindergartens, homes for elderly, public housing). This tool allows municipalities to realize public developments at strategic places respecting inner urban development and minimal land take.
- New funding schemes for housing to improve intensification of settlements Public aid for housing is an enormous economic factor in Austria and amounts to 1 % of the GDP. The provinces have their own funding schemes with the objective to facilitate affordable quality housing for all citizens. In recent years the funding schemes focused on the development of new single family houses with high energy standards. Today all provinces are continually redesigning their funding schemes and integrating land take aspects. New housing on already developed land and modernization of existing buildings are now central issues. The provinces Vorarlberg and Tyrol are most advanced in this respect. To give an example, the housing funds of the province Tyrol supported 2,500 housing units in 2008. Two thirds were directed to new buildings and one third to renovation of the already existing housing stock. One year later the funding rules were changed in favour of renovation. With about the same budget 4,100 housing units received funding, of which 60 % were renovated and 40 % newly built. The renovation programme influenced the local job market positively, since renovation is more work intensive than building.
- "Soil efficient" business developments. In many provinces co-operation of municipalities is highly encouraged for the development of new commercial areas (see best practice below).

Reuse of Brownfield land. Austria has no specific programme to enhance the reuse of Brownfields. In 2004 a survey was carried out to analyse the national Brownfield situation. In

this context derelict and underused land from industry and commercial activities was surveyed. Results revealed that the extent of Brownfields was enormous with 130 km², which corresponds to the territory of Graz, Austria's second largest city. Furthermore, a yearly increase of brownfields with up to 11 km² was observed. Another interesting finding was that brownfields are dispersed all over the country. Specifically affected are small towns in rural regions with decreasing population and low real estate prices. Recently several soft measures were launched to increase the reuse of brownfields; including a guideline for investors and a new standard for the assessment of property values [8]. Financial risks in the case of contamination are still considered to be the major barrier for investors. An improvement of this situation cannot be expected in the near future.

Protection of the best agricultural land and landscape fragmentation. The spatial planning laws of some Austrian federal states allow identification and delineation of priority "agricultural areas" and/or "protected green areas". Soil protection is not explicitly mentioned as a goal but is, however, implicitly covered by the various roles soils fulfil in ecosystem functioning. Soil quality is mostly one of the criteria to delineate the priority agricultural areas. Prevention of landscape fragmentation is the key objective to delineate "protected green areas". Both categories do not allow a conversion into building land and are protected towards new developments. To give an example; in a very small rural community 25 km outside Vienna a major railway station will be completed in the next years providing a direct high speed connection to Vienna. The community can expect numerous new settlers due to this attractive railway connection. In order to avoid vast uncontrolled urban sprawl the community delineated protected green areas in their local zoning plan.

2.2.3 Best practice

Joint regional planning: Vision Rheintal. Rheintal - one of Europe's most prospering regions - is a region close to the Swiss boarder. The region is an agglomeration of several small cities and highly affected by urban sprawl. 29 municipalities have committed themselves to an integrated approach for the whole region, with special focus on the reduction of land take and soil sealing, improvement of public transport, increasing the quality of living and protection of landscape[15]. A milestone was the resolution and the signature of the regional contract Rheintal by the members of the Rheintal. The county Vorarlberg and the 29 municipalities confirm their common responsibility for the Rheintal and their willingness for collaboration [12].

Inter municipal business settlements. In the past many small municipalities failed in developing their own business parks, because of their limited resources. Many of these projects are today "new brownfields". It is now common that municipalities combine their resources and share the risks and benefits. The most advanced province in this respect is Upper Austria. TMG is a public agency in charge of facilitating new business settlements in Upper Austria. The development of new business locations is an important tool for municipalities to attract new business settlements and new income. However, many Austrian municipalities have already failed and in fact created new brownfields. As a reaction TMG has developed the concept of "intermunicipal business location" (INKOBA[16]). Municipalities co-operate in developing and advertising one common location and share the costs and revenues. By concentrating the efforts of several municipalities the overall land take is lower compared to several smaller projects and the chance that developed locations are efficiently used is higher.

15 Vision Rheintal: http://www.vision-rheintal.at/hintergruende/
16 INKOBA: http://www.inkoba.at/

TMG assists in professional planning and finding the right contractual agreements among the partners. In total more than 20 INKOBA projects were successfully realised, the largest including 49 municipalities.

Protection of soil functions. The protection of soil functions is a key objective of the Salzburg soil protection law. The province has recently published a guideline[17] how to respect soil functions in spatial planning, in particular along strategic environment assessments. Practical applications are typically regional development plans (in particular the zoning of building land) and large development projects (see also chapter 5 on soil quality criteria).

2.2.4 Conclusions

In 2006 Austria's index for artificial surface corresponds to the EU average with 496 m² per inhabitant. The index remained fairly stable in the period 2000 to 2006.

However, due to its Alpine structure space for new developments is already scarce in many Austrian regions, in particular in the Western provinces. Up to the turn of the century the big Alpine valleys and the surrounding regions of the big cities were heavily affected by rapidly increasing land take and soil sealing.

Loss of soil through sealing and urban sprawl are fairly recognised in Austrian policy. In 2002 Austria published a National Policy Target for the reduction of soil sealing, which will not be reached. However, since the turn of the century a decreasing trend with regard to land take and soil sealing can be observed. The Austrian provinces have recently adopted their spatial planning laws and introduced new instruments to reduce the annual land take. It is evident that current measures are not sufficient to achieve a more rapid reduction of annual land take. For this reason the Ministry of Environment assigned a policy review, which is currently being published under the title "*Enough Ground?*" [11]. A key conclusion of the report is that instruments at the planning level exist sufficiently but need to be more intensively implemented (no need for more regulation). The provincial governments have made visible progress due to introducing new instruments in their spatial planning laws and adopting their funding schemes for housing. However, the ambitions in the provinces are very different and an exchange of experience is lacking. For the future concerted action of all political stakeholders is needed in order to improve the overall land use efficiency in Austria. Key avenues to pursue are the ban of controversial public subsidies, the improvement of the quality of living in inner urban areas, the compensation of economic disadvantages when developing inner urban areas, and increasing public awareness already in schools, and to improve the knowledge base of decision makers.

17 Amt der Salzburger Landesregierung (2010): Bodenschutz bei Planungsvorhaben. Leitfaden (translation: Respecting soil protection in spatial planning. Guideline

2.3 Belgium

Geography. Belgium has three main geographical regions. Firstly: the coastal plain in the North-West, which consists mainly of sand dunes and polders. Secondly the central plateau, which is a smooth, slowly rising area that has many fertile valleys and is irrigated by many waterways. The third geographical region, called the Ardennes, is a thickly forested plateau; it is very rocky and not very suitable for farming.

Demography. Belgium's population growth is slightly above the EU average. Like in any other EU member State urban agglomerations are growing faster than rural regions.

2.3.1 Land take and sealing

Land take and sealing. Belgium is highly affected by urban sprawl, fragmentation of landscapes and soil sealing. The Northern part of Belgium is the most fragmented and second most sealed region in Europe.

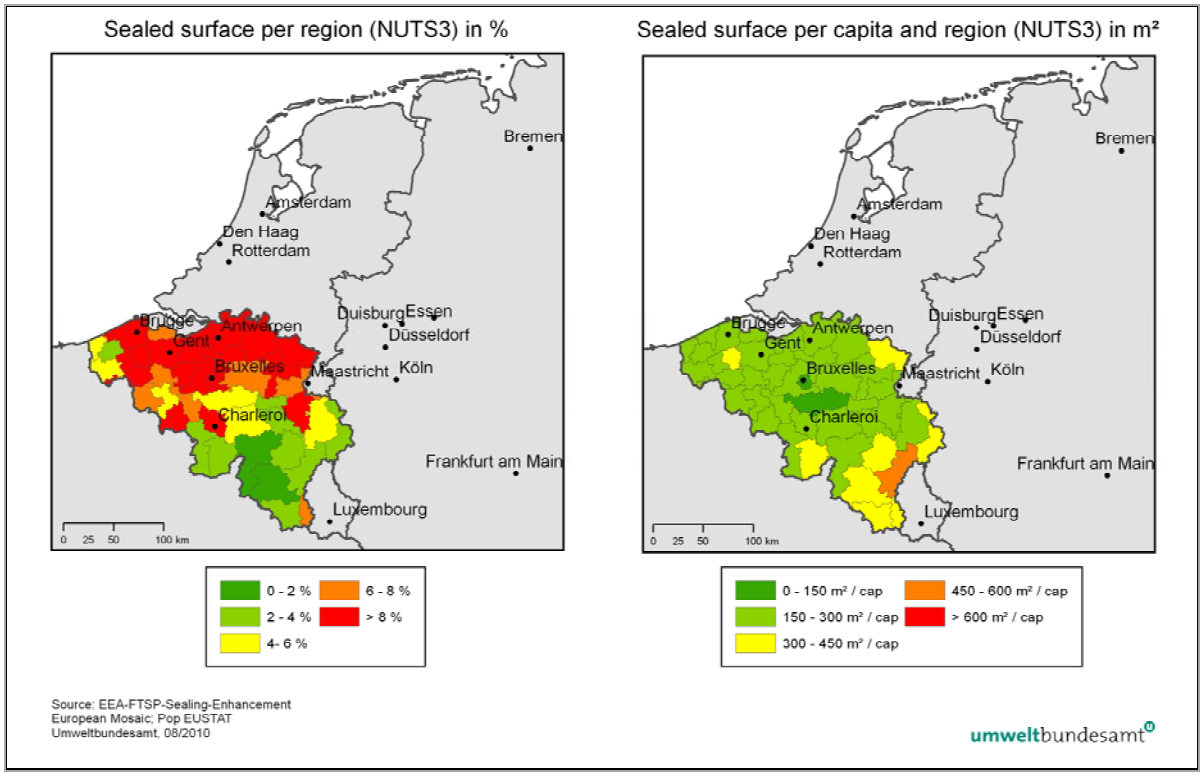

Fig. 14 Belgium: Soil sealing per region in 2006.
Source: EEA, EUROSTAT

Comparison with other EU Member States. The average artificial surface per capita is very high in Belgium with 600 m² per capita in comparison with other EU Member States. Belgium had the lowest increment of artificial surface between 2000 and 2006 with only 0.4 % and annual land take per capita was below 1 m². Key reasons are the fact that more and more developed land is reused and a visible reurbanisation trend in particular in the Brussels agglomeration, with more people moving back to the city centre.

Population growth amounted to 2.7 % in the same period. It was hence possible to increase land use efficiency. This fact is visible in the index for artificial surface per capita which decreased from 613 m² per capita to 600 m². The amount of sealed surface per capita is at 215 m² which is only slightly above the EU average of 200 m² per capita.

Between 1985 and 2009 the amount of land take increased by 30 % - from 4,700 km² to 6,150 km² (see also Fig. 15). About two thirds of the land take were caused by the private sector (households)[18].

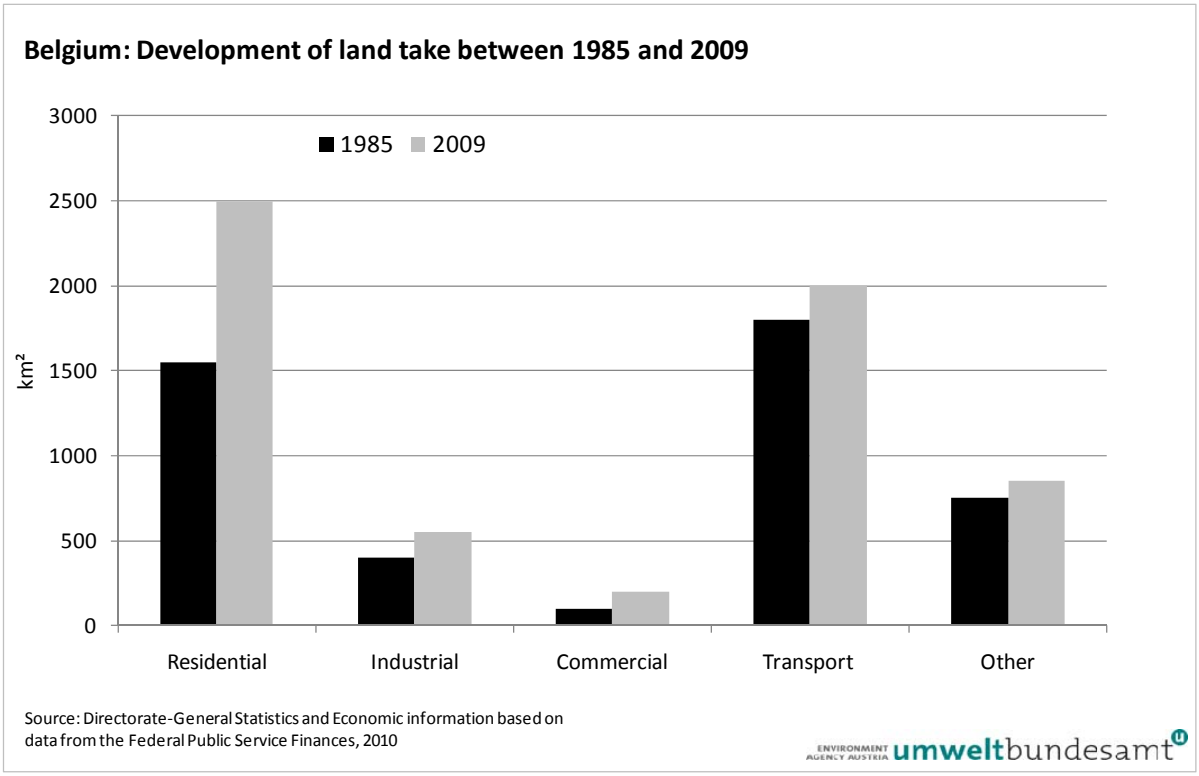

Fig. 15 Belgium: Development of land take between 1985 and 2009.
Source: Directorate-General Statistics and Economic information based on data from the Federal Public Service Finances.

The three Belgium regions are differently affected by urban sprawl and soil sealing:

- Brussels. The Brussels-Capital Region, being a large city with a high density of population, has the highest share of built-up area, with 78.4% of the territory covered by residential and commercial buildings, public infrastructure, transport infrastructure, etc. (including also private gardens and recreational areas). The percentage of sealed soil increased from 18 % of the territory in 1950 to 37 % in 2006, see also Fig. 16 [13] [19].

18 The increase of land take in this period is about the double compared to the Netherlands (compared with TCB report); i.e. 3.9 m²/cap and year in Belgium in the period 1985 – 2006 and 2.1 m²/cap and year in the Netherlands in the period 1964 – 1998.

19 The city districts with the highest share of sealing were identified to be Etterbeek, Saint Gilles and Saint Josse, with more than 75 % sealing.

- The Flemish Region. *"Flanders is hermetically sealed"*, states the Flemish Report on the environment, more than a quarter of the territory is covered by built-up area and about 13.8 % of the territory is actually sealed (MIRA)[20].
- The Walloon Region is - compared to the other regions – less urbanised with a share of built-up area of approx. 14 % and an estimated sealing share of 2.6 %.

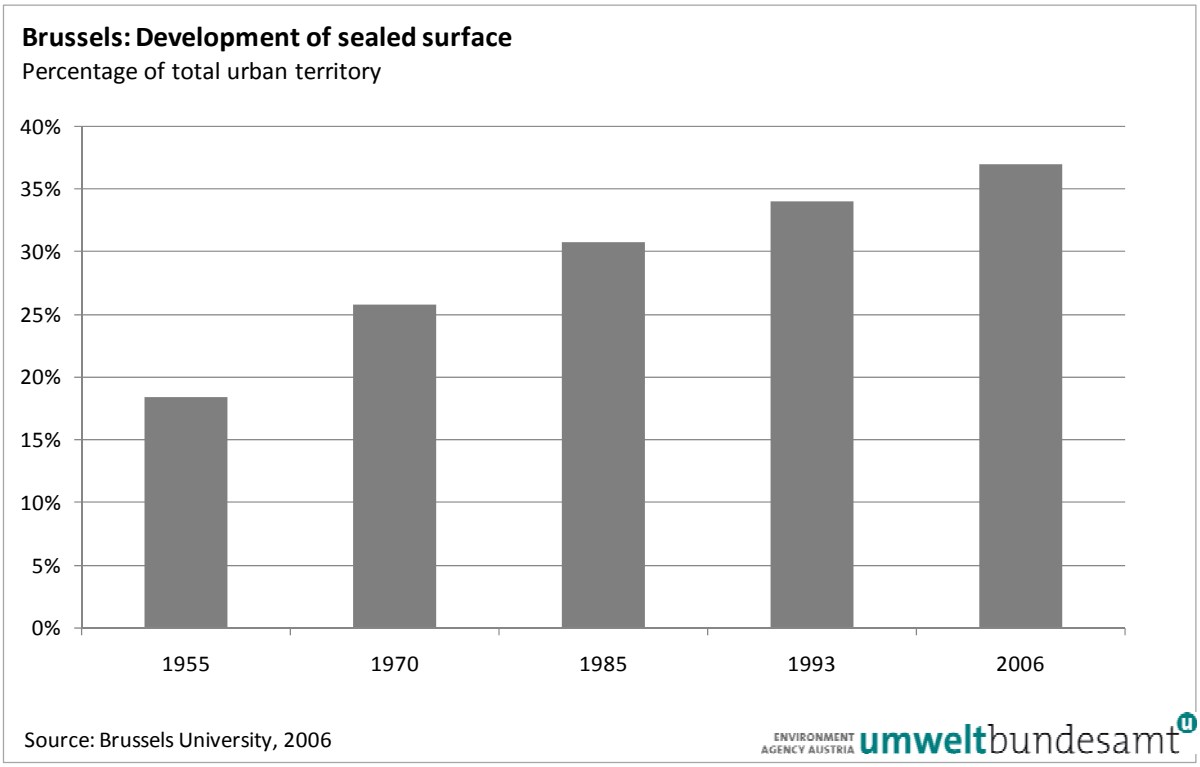

Fig. 16 Brussels: Development of sealed surface between 1955 and 2006.
Source: Brussels University, 2006

2.3.2 Policies of interest

The Flemish Region. In 1997 the *Spatial Structure Plan for Flanders (RSV)* was enforced for the period 1997-2007. The plan represents a clear commitment to sustainable spatial planning [14] and put special emphasis on reducing urban sprawl. The document claimed a spatial limitation for new developments, with 60 % to be realised in urban areas and only 40 % in rural regions until 2007. The Spatial Plan[21] was revised in 2004 and provides binding regional targets for spatial development, with even more precise development targets and provides a far more integrated approach towards urban development [15].

Policy evaluation. Soil sealing and the implementation of the Spatial Structure Plan are being monitored and results are published in the annual Environment Report. In 2007 the Flemish Environment report concludes "Flanders is hermetically sealed", since according to the latest data surveys 13 % of the Flemish territory was actually sealed. The policy evaluation

20 Milieurapport Vlaanderen (MIRA), http://www.environmentflanders.be/
21 Ruimtelijk Structuurplan Vlaanderen 2004

report MIRA-T "*Flanders Environment report – Policy Evaluation*" is published in the same year. With regard to Flanders spatial planning policy the following conclusions are drawn: (1) the policy target of 60 % development in urban areas until 2007 was not reached, (2) land take in rural areas is still steadily decreasing, (3) stricter implementation of the Spatial Structure Plan was necessary and meeting the policy target was imperative [16].

In 2010 another revision of the RSV is published. The planning period is extended to 2010. The revised version states "in general it can be observed that the policy target for new developments will be met; i.e. 60 % of new development in inner urban areas. Furthermore, the RSV states that inner urban development is currently supported by the general trend that people tend to move back to urban areas since 2000. The revised RSV requires that more emphasis is put on renovation and conversion of existing buildings and states that about 10 % of existing housing were not meeting current standards [17]. The new Flemish Spatial Policy Plan for the period 2020-2050 focuses on climate change, sustainable development and spatial changes. Besides this, there is also a growing cooperation between the environmental, spatial and transport policy fields and their corresponding planning processes.

Brownfield recycling. The redevelopment of brownfield sites is of key importance in Flanders; space is limited and efficient land use a national priority. The most recent development in this respect is the *Brownfield Covenant*, a principle which was introduced in August 2007[22], with the overall objective to promote the reuse of brownfields by providing incentives for land developers. A Brownfield covenant is an agreement between the Flemish Government and one or more private or public parties which foresees arrangements in order to promote a smooth and efficient realization of a Brownfield project. In this manner the Flemish Government aims to stimulate project developers and investors to redevelop abandoned and contaminated sites (Brownfields), rather than new areas (Greenfields). The process is managed by the Flemish Enterprise Agency[23] (VLAO). In the first year of operation 21 Brownfield Covenants were approved by Flemish Government. As soon as a Brownfield Covenant is concluded, a number of facilitating measures come into force in the form of juridical-administrative as well as financial advantages for developers and investors (see chapter Luxembourg, IVL, page 109).

The Walloon Region. Since the Walloon Region was not as severely affected by urban sprawl and soil sealing as Flanders the issue was for a long time not a priority on the political agenda. The *Development Scheme for Spatial Development (SDER)*[24], as adopted in 1999, is the central programming document for spatial development. It includes a general commitment to sustainable development and the protection of natural resources but no specific claim to reduce urban sprawl or soil sealing.

The scheme has not been adopted since enforcement and is in many aspects not adequate to meet the future challenges of the Walloon region. In particular noteworthy is a new move of the Environment Minister Mr. Philippe Henry who is currently in charge of revising the SDER. He proposes a joint concept for the Walloon region and the Brussels region. For both regions a continuation of urban sprawl and growth of commuter traffic can be expected if the status is continued. The new SDER shall pave the way for a new mobility concept and the improvement of urban quality. Key objectives are the reduction of private car commuters by improving the public transport system, and to introduce a stricter zoning for land develop-

22 On June 19th 2007, the decree of March 30th 2007 concerning the Brownfield covenants came into force: Besluit van de Vlaamse Regering van 7 september 2007 betreffende de informatieplichten in het kader van Brownfieldconvenanten

23 Agentschap Ondernemen, http://www.vlao.be/default.asp?webpageID=313

24 Le Schéma de développement de l'espace régional (SDER), dopté le 27 mai 1999 http://developpement-territorial.wallonie.be/

ment. According to his plans new development zones shall only be realised along strong public transport routes. The new concept which has many similarities to the Luxembourg concept (IVL see page 109), is subject to a large consultation process and shall be implemented from 2012 on.

In the Walloon Region, 23 sectoral plans (plans de secteur (PDS)) aim to manage the pressure that urbanisation puts on the territory by defining zones which can be built on and zones to be used for agriculture, forests, or wildlife. Since 2005, any new zone to be urbanised must be compensated. (http://www.eea.europa.eu/soer/countries/be/land-use-national-responses-belgium)

Research. The publication *Village Durable (Sustainable Villages)* is a study with regard to spatial development in the rural regions of Wallonia. In particular the new functions of rural environment are analysed, which are today above all housing, recreational values, and the provision of renewable energies. The publication gives guidance for sustainable development in villages and puts emphasis on the protection of green areas, containment of landscape fragmentation, and restrictions to the zoning of new development land.

2.3.3 Best practice

The Spatial Structure Plan for Flanders (RSV) is supported by a specific funding programme for strategic projects for sustainable spatial development. Key objectives are to financially support local governments in carrying out sustainable land development projects. This includes the acquisition of land for strategic development projects, the remediation of run down areas and the establishment of green urban areas. The local governments can submit their proposals to the spatial planning department of the Flemish government, where they are ranked for approval. In 2010 seven strategic projects with a total funding of 2.1 million euro were approved including[25]:

- Brownfield recycling. The municipalities of Vilvoorde and Machelen are jointly developing a large brownfield to establish an area for business and recreational use.
- Station areas. In the cities Kortrijk, Roeselare, Ingelmunster, and Izegem the areas around the central railway station are currently being renewed in order to attract more train commuters.
- New recreational areas. The Zennetal is highly impaired by landscape fragmentation and urbanisation. Four municipalities are co-operating in establishing a large recreational park for residents.

2.3.4 Conclusions

Flanders. Natural landscapes, recreational areas, and agricultural land are already scarce in Flanders. A very ambitious Spatial Plan was published as early as 1997, which claimed that 60 % of all new developments were to be realised in inner urban areas. A policy review in 2007 stated that this target was not met. However, after a second revision of the Spatial Plan first positive results can be observed. It can be assumed that Flanders will meet its policy target by 2012. Currently special emphasis is put on reusing and renovating the existing housing supply. Moreover there is a visible trend that people tend to move back to urban areas.

25 Description of the strategic projects of the Spatial Structure Plan for Flanders: http://www.rsv.vlaanderen.be/nl/strategischeProjecten/

Walloon region. The development scheme for spatial development is currently under revision. The new environment minister plans an integrated approach in co-operation with the Brussels region with the overall objective to reduce urban sprawl and private car traffic, and to allow new developments only along strong public transport routes.

2.4 Bulgaria (short country profile)

Geography. Bulgaria features a highly diverse landscape: the north is dominated by the vast lowlands of the Danube and the south by the highlands and elevated plains. In the east, the Black Sea coast attracts tourists all year round. About 31% of the territory is made up of plains, while plateaus and hills account for 41%. Low mountains (600 to 1,000 m) cover 15 %, medium-sized mountains (1,000 to 1,500 m) 10 % and high mountains (over 1,500 m) 3%.

Demography. Population density generally low with less than 60 inhabitants per km². The highest population density is characteristic for the South-western Region (103.9 cap/km^2). Most of the population (71%) resides in urban areas. This is an indication for a general drop in urbanization in both quantitative and qualitative respect. Bulgaria has one of the lowest population growth rates in the world. With some minor exceptions the population in almost all settlements in the country is diminishing and that not only in the villages, but also in the cities, and even in the large cities.

Land take and sealing. In 2006 the share of artificial surface amounted to 5 % and the share of sealed surface to 1.8 % which corresponds more or less to the EU average. Between 2000 and 2006 artificial surface growth was very moderate with 0.7 %. Due to the already sparse population density, which is shrinking further, the population land use intensity is very low with 722 m² artificial surface per capita. This is twice the EU average.

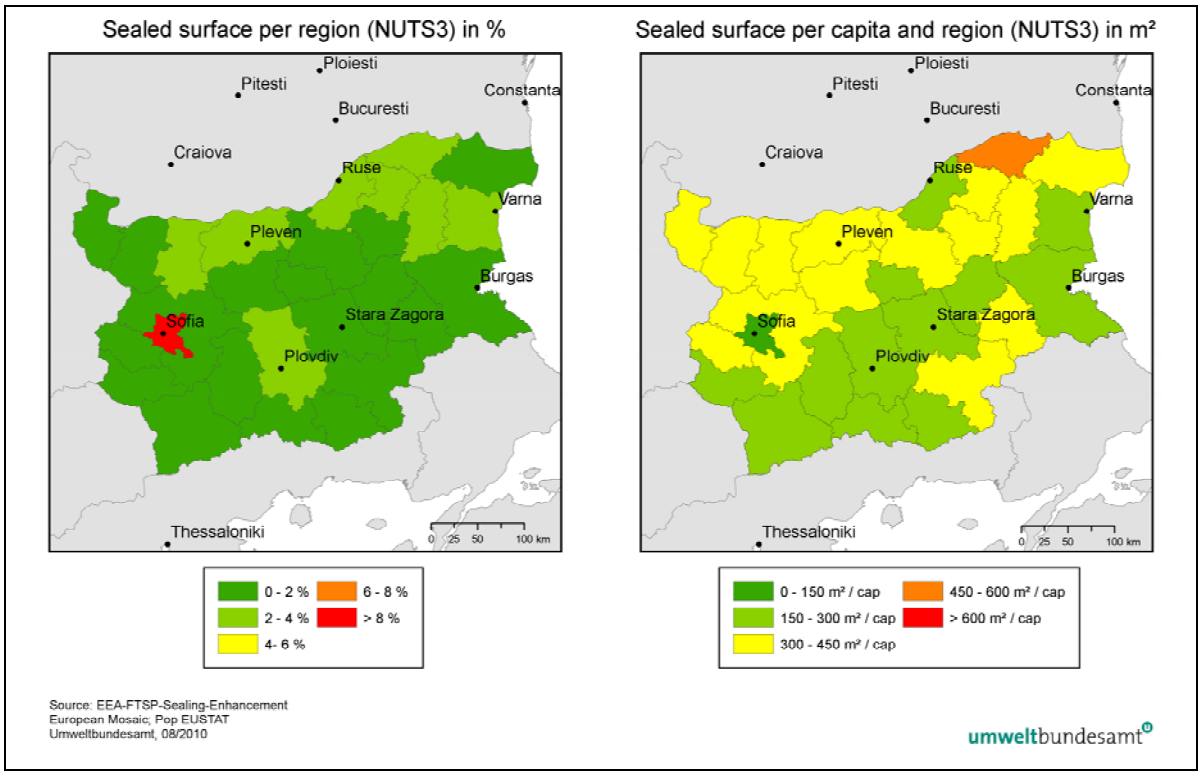

Fig. 17 Bulgaria: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Policies of interest. The Ministry of regional development and public works is responsible for sealing and spatial planning issues. There is no developed system to effectively control

soil sealing or increasing land take.

The National Regional Development Strategy outlines the strategic objectives of the regional development of the country for the period 2005 to 2015 [18]. Specific references to the reduction of land take or soil sealing are not made. The document clearly depicts "*central highly urbanised areas*" as development centres (see Fig. 18).

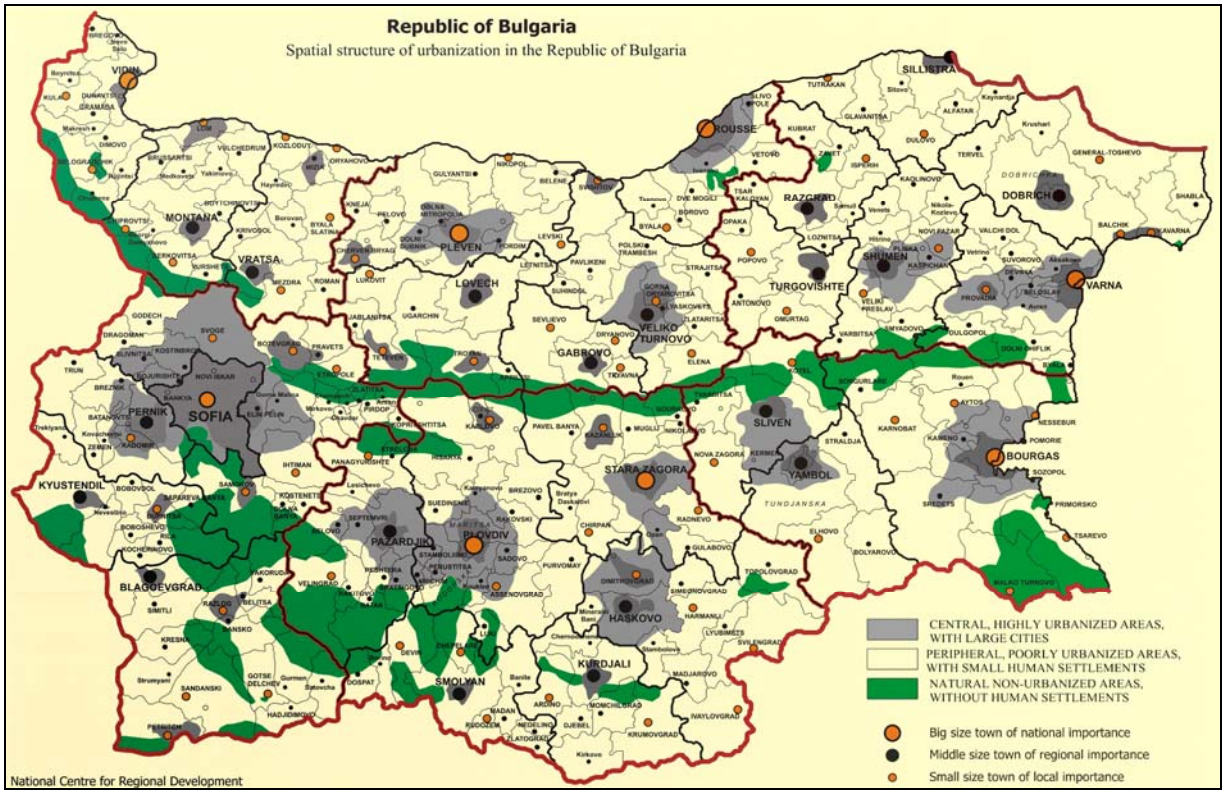

Fig. 18 Spatial structure of urbanization in the Republic of Bulgaria
Source: NRDS (National Regional Development Strategy) for the period 2005-2015

Relevant legal documents are [28]:

- the *Soil Act*, enforced in 2007, which focuses on soil protection,
- the *Law on Spatial Planning* last amended in 2009 which in particular regulates spatial planning in urbanised territories. Art.9, (2) makes specific reference to restrict the uncontrolled building (i.e. soil sealing). "*Unfortunately, this Law has failed to reduce the strong urbanization and uncontrolled building up of resort areas in particular along the Black sea coast in the past 10 years*", is argued by national experts.
- the *Law for the Black Sea coastline* from 2008, last amended in May 2009, aims at protecting coastal landscapes, and
- the *Protected Areas Act* introduces a restrictive regime in relation to construction within the protected areas and the Natura 2000 areas.

Conclusions. Pressures from land take and soil sealing are generally low and reduced to a few hot spot areas such as the urban agglomeration of Sofia, the Southern coastline, and mountain resorts in the towns Bansko and Pamporovo.

Bulgaria is struggling with a strongly declining population. Legal instruments to protect soils and control spatial planning in sensitive areas exist but land take and soil sealing are not

priority issues in Bulgaria.

2.5 Cyprus (short country profile)

Cyprus acceded to the EU on 1st May 2004 as a de facto divided island. As a result, according to Protocol 10 of the 2003 Accession Treaty, Cyprus as a whole entered the EU, whereas the application of the acquis is suspended in the northern part of the island (defined in the Protocol as the "areas of the Republic of Cyprus in which the Government of the Republic of Cyprus does not exercise effective control").

Geography. Cyprus is with 9,259 km² the third largest island in the Mediterranean Sea. The physical relief of the island is dominated by two mountain ranges. The main cities of Cyprus are Nicosia, Limassol and Larnaka. The Average population density is 82 inhabitants per km².

Demography. Cyprus population grew considerably since its independence in 1960. Between 1990 and 2006, the population increased by 33% which is the highest growth rate in EU 27. Cyprus is dominated by touristic infrastructure which takes much of the available land, which on the other hand is used mainly during the touristic season in summer.

Land take and sealing. With a sealing rate of 3.6 % and a share of artificial surface of 8.5 % Cyprus is under enormous land use pressure. Due to dominating touristic infrastructure land use intensity of artificial surface is the lowest in EU 27; meaning that for each inhabitant 1,032 m² of artificial surface are available (three times EU average).

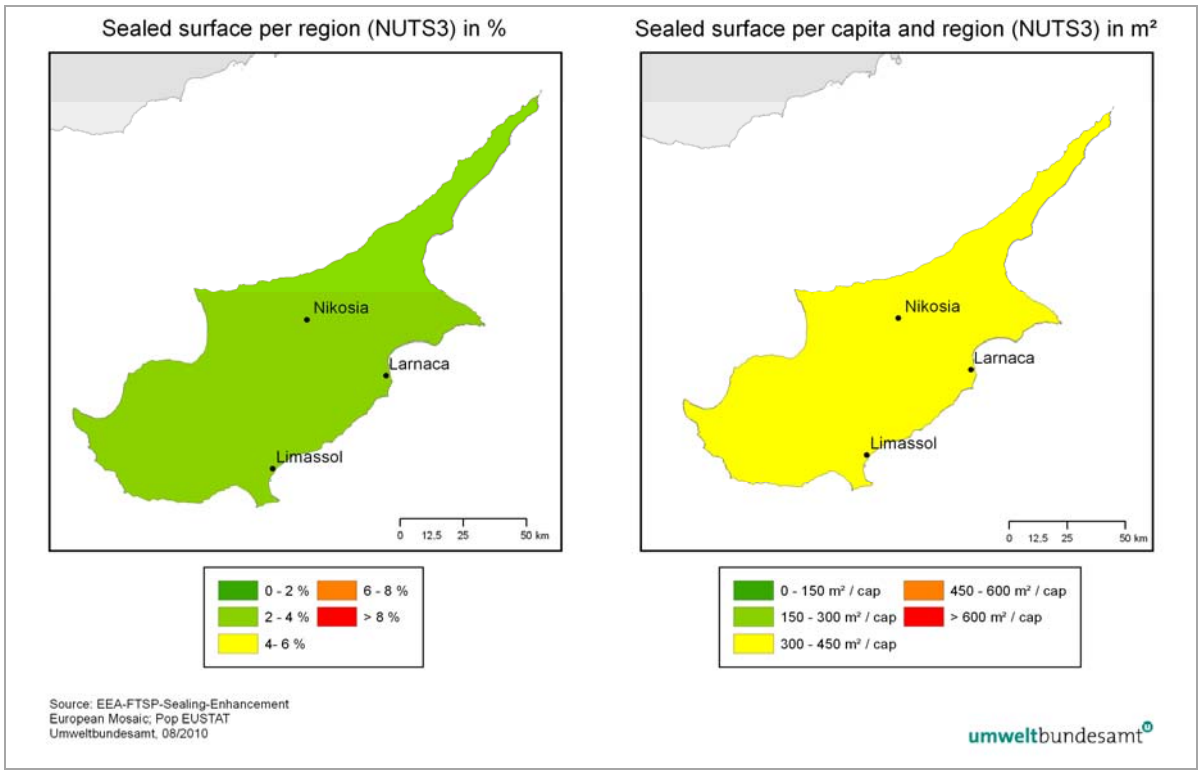

Fig. 19 Cyprus: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Conclusions. Due to rapidly growing population and touristic infrastructure land use pressures are significant in Cyprus. Water pollution, erosion, and wildlife preservation are perceived as major environmental challenges. Regarding measures to reduce soil sealing or land take the authors were not able to obtain any further information.

2.6 Czech Republic

Geography. The Czech landscape is exceedingly varied. Bohemia, to the west, consists of a basin drained by the Elbe and the Moldau rivers, surrounded by mostly low mountains, such as the Sudetes, with the highest mountain at 1,602 m. Moravia, the eastern part of the country, is also quite hilly. It is drained mainly by the Morava River and secondly by the Odra River. The plains of Bohemia and Moravia are both rich in fertile soils and almost 40 % of the countries territory is classified as arable land.

Demography. Unlike other new Member States from Central and Eastern Europe Czech population was only slightly shrinking between 1990 and 2000 population (-0.8 %). Since 2000 population is more or less stagnating and from 2006 on moderate population growth can be observed. Recent demographic developments in the Czech Republic show clear urbanisation trends in the metropolitan regions of Prague, Ostrava, Bruno and Pilsen whereas all other regions suffer from decreasing population.

2.6.1 Land take and sealing

In 2006 the index for artificial surface was significantly above EU average[26] with 490 m² per inhabitant. In the period 2000 to 2006 the amount of artificial surface increased by 2 %. The amount of sealed surface is above EU average with 243 m² per capita.

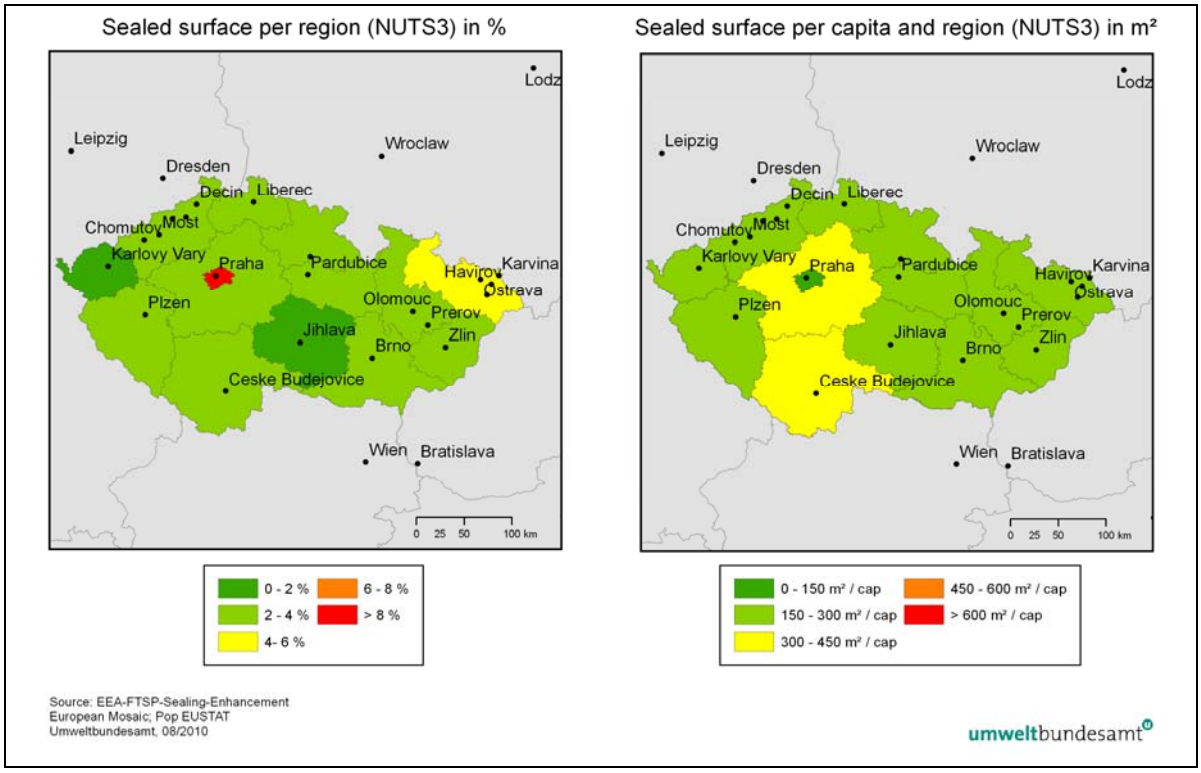

Fig. 20 Czech Republic: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Data referring to the annual land take are generated by the Czech Authority for Land use

26 EU average according to EU Land Cover layer 2006: 386 m² per cap

Data[27] and show a faster increase of land take compared to population growth for the period 2000 to 2008; land take increased by 2.5 %, whereas population only by 1 % (see Fig. 42). The land take for settlements and transport infrastructure is estimated to amount to approximately 16 hectares per day [19].

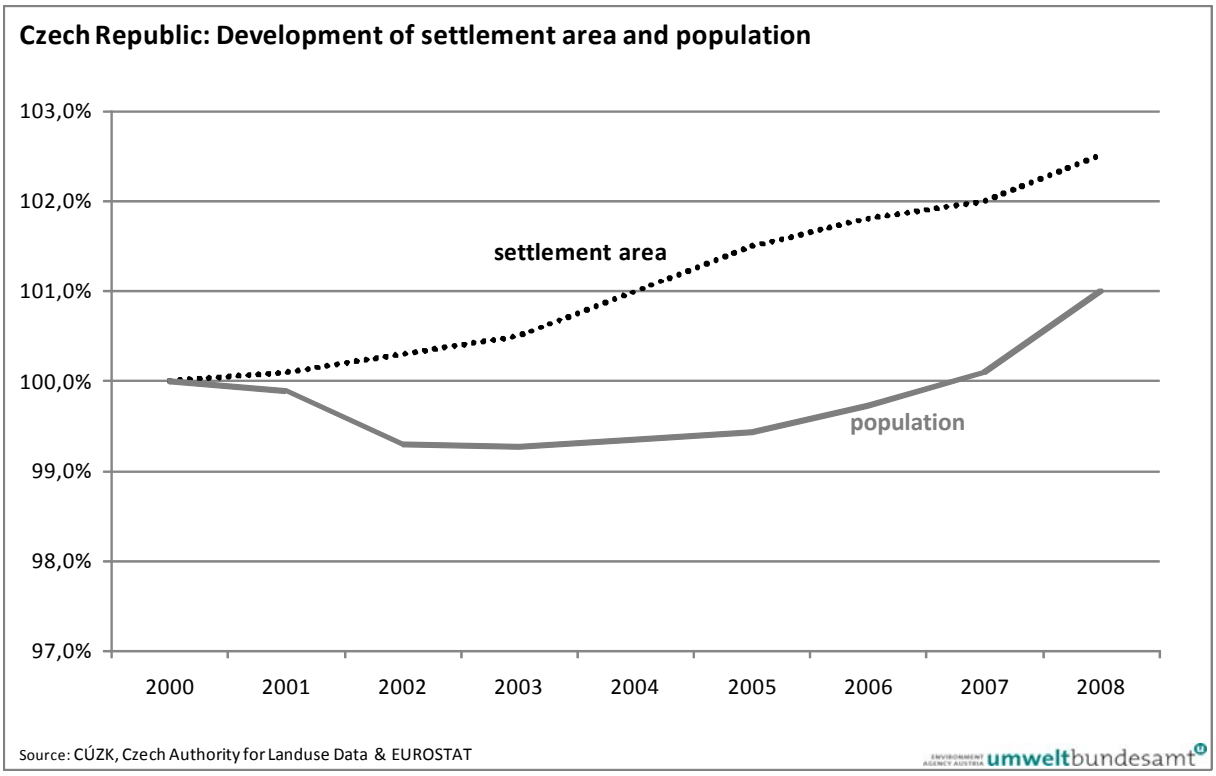

Fig. 21 Czech Republic: Development of settlement area and population

Source: ČÚZK, Czech Authority for Land use Data [20]

The transition of the Czech Republic to a market economy was also reflected in a recent reform of spatial planning competences. In 2006 administrative structures changed significantly and spatial planning competences were delegated from the state level to the regional level. In 2007 the Building Act[28] was enforced, which adjusted planning powers of regions and local authorities. The 6,250 Czech municipalities have planning powers, allowing them to approve local developments. The 14 Czech regions have a coordinative role; they regulate land management mainly through policies, strategies and dedicated funding programmes.

2.6.2 Policies of interest

In 2008 the *Spatial Development Policy 2008* of the Czech Republic was published [21]. The priorities of this document clearly refer to supporting polycentric developments, strengthening brownfield redevelopment, and protecting green zones from land take and fragmentation.

Regulation of urban sprawl and protection of urban greens. One of the latest achievements is the publication of the *Principles of Urban Policy* by the Ministry for Regional Development. The document lays down the principles of urban spatial planning policy in recogni-

27 ČÚZK Český úřad zeměměřický a katastrální; http://www.cuzk.cz/
28 act 137/2006 Sb.

tion of the Leipzig Charta[29]. Key achievement is the integrative approach considering environment aspects, spatial planning and regional development.

Three policy documents protect the consumption of green land inside and outside city boarders and give priority to inner urban developments, namely the building code, the act on nature conservation, and the act on the protection of agricultural land.

- High quality soils in the outer city belt are protected by the act on the protection of agricultural land[30] (see also below).
- The protection of green areas within city boarders is regulated by the Act on Nature Protection[31].
- To give priority to the development of abandoned areas (old industrial estates) instead of developing green land is regulated by the Building Code[32].

The above mentioned policy document is complemented by national research project funded by the Ministry of the Environment. The project is called *Suburbanizace*[33] and aims to assess the extent and intensity of suburbanisation and to increase awareness among the public and developers. Final goal of the project is to promote means of prevention of negative impacts of suburbanization to key public and private actors [22].

Reuse of brownfield land. Already in the end of the 1990ies the Czech Republic started to pick up the issue of brownfield redevelopment as a spatial response to ongoing societal changes. Today the *Czech Invest* acts as central brownfield agency in the Czech Republic - an agency of the Ministry of Industry [23]. The agency was founded in 1992 with the intention to attract new investors and to facilitate new business settlements. The focus on brownfield redevelopment emerged several years later and was the output of a PHARE project[34]. Among other findings the project provided a good overview of the whole national brownfield situation, estimating the number of brownfield sites with about 10,000 and qualifying most of these sites as medium-sized real estates with no industrial origin. Brownfield redevelopment received special attention in the ERDF programming periods 2000 – 2006, and 2007 – 2013. Several attempts to enforce a National Brownfield Strategy failed however. Brownfield redevelopment is a key principle of the *Principles of Urban Policy* document, which was recently published and enforced (see above).

Protection of the best agricultural land. Based on the *Act on the Protection of Agricultural Resources*[30] the conversion of agricultural land to building land requires a compensation fee. Since the fee is not very high (less than 1 Euro per m²) many experts are of the opinion that the instrument cannot be considered as a barrier for investors. Since introduction of this mechanism in the year 2000 the annual income from conversion of agricultural land decreased by more than 50 %. This trend matches the general decrease of annual land take

29 The "Leipzig Charta on Sustainable European Cities" was signed by the Ministers for urban development from all EU Member States under the German EU presidency in 2007. The Charta represents a clear commitment to sustainable urban development and includes 9 key recommendations. Improvement of the quality of living by creation and conserving green public places and the improvement of public transport are central claims and considered as solutions to reduce urban sprawl.

30 Act No. 334/1992 on Protection of Agricultural Land Resources as amended by Decree No. 13/1994 defining certain details of the protection of agricultural land resources,

31 Act No. 183/2006 about Landscape Planning and Construction Regulations

32 Act No. 114/1992 Coll. on Nature Conservation and Landscape Protection, as amended by the following regulations: execute regulation No. 395/1992 implementing certain provisions of the Act on Nature Conservation and Landscape Protection

33 Research project of the Ministry of Environment (2007 - 2011). Title Suburban development, Suburbanisation and Urban Sprawl in the Czech Republic: Tackling the Negative Impacts on the Environment (http://www.suburbanizace.cz/)

34 Czech Brownfield Regeneration Strategy, CSF, PHARE project EuropeAid/113183/D/SV/CZ, lead consultant Parsons Brinckerhoff (2004)

after 2000, as provided by the CORINE Land Cover assessment in Tab. 2. This trend can be explained with the completion of major infrastructure projects before 2000.

The Czech Ministries for Agriculture and Environment are currently preparing an amendment of the Act on the Protection of Agricultural Resources in order to increase the fees for withdrawal of land from the agricultural land resources. [24]. More information about this compensation instrument can be obtained in chapter 4.1.1 “compensation systems”.

2.6.3 Best practice

Brownfield programme in Usti. The region of Ústí has 820,000 inhabitants, most of which live in the 46 smaller cities of the region. The region is a clear candidate for massive urban sprawl, since economy is gradually improving and the region represents an important corridor on the route from Prague to Germany. The Ústí Region’s sustainable development strategy[35] for the period up to 2020 includes a specific thematic strategy for brownfield redevelopment. Special focus is put on the redevelopment of environmentally hazardous sites and on putting restrictions on uncontrolled development of greenfield sites outside the settlement boundaries. Specific targets up to 2020 are to reduce the number of brownfield sites, the number of undeveloped environmentally hazardous sites, and the area of new land being built on. In order to achieve this goal Ústi is currently implementing the principle of circular land use management. (Circular land use management primarily focuses on systematically exploiting the potentials of existing structures and reusing derelict land). Ústi is currently partner in a project on territorial co-operation (CIRCUSE see also page 197), focused on this issue. Furthermore, brownfield redevelopment projects with support of the JESSICA funds are currently being planned.

The Urban and Regional Lab (URRL)[36] of the Charles University in Prague is a remarkable group of researchers focusing on research projects related to urban sprawl. The group manages several research projects in this thematic field and publishes also in English [22].

Brownfield regeneration based on the JESSICA funds. In 2010 the region Morawia-Silesia was able to establish a funds of 20 Million Euro for the redevelopment of urban brownfield areas based on the JESSICA funding scheme of the EU structural funds (see also page 198) [25].

2.6.4 Conclusions

Soil protection, limitation of urban sprawl, valuation of agricultural soils, and reuse of brownfield land are well reflected and incorporated in several policy documents. The perception of the problem is clearly visible and several measures are undertaken to avoid further soil loss by sealing. Most measures are very new and therefore lack detailed reviews.

In particular noteworthy is the legal requirement that consumption of high quality agricultural soils needs to be compensated. Since implementation of this mechanism a decreasing trend of soil consumption can be observed. However, according to national experts the fee is too small to present a barrier for new developments. The land take around Prague is expected to grow continually, despite the fact that the best agricultural land is located there, because there are no alternatives for developers. *“The current legislation doesn’t protect the land as we would like to, however without it the losses of agricultural land would be significantly*

35 Source: regional web www.kr-ustecky.cz
36 Website: http://www.suburbanizace.cz/

higher.", is a statement from an expert of the Environment Ministry [24].

The funding mechanisms of the EU structural funds are seen critical in the light of sustainable spatial development. Many new logistic centres are currently being planned with EU funding and create new land take, many of which will last only a few years. Special incentives to steer new developments to already developed land are missing at the EU funding scale (with the JESSICA funds as the only exception) [26].

2.7 Denmark

Geography. Denmark is located on the Jutland peninsula and several islands in the Baltic sea. It sidelines both the Baltic Sea and the North Sea and has a coastline of in total 7,987 km. The local terrain is generally flat with a few gently rolling plains. The 43,096 km^2 of the country are almost entirely low-lying, and more than 65 % of the land area is cultivated.

Demography. 85 % of the population lives in towns and settlements with more than 200 inhabitants and 15 % in the countryside and in smaller villages. About 2.7 million inhabitants live in a 50 km radius around Copenhagen, making it the most densely populated area in Northern Europe.

2.7.1 Land take and sealing

Sealing and land take. Land use pressures are significant in Denmark. In 2006 about 3.6 % of the national territory is sealed and 7.6 % is classified as artificial land.

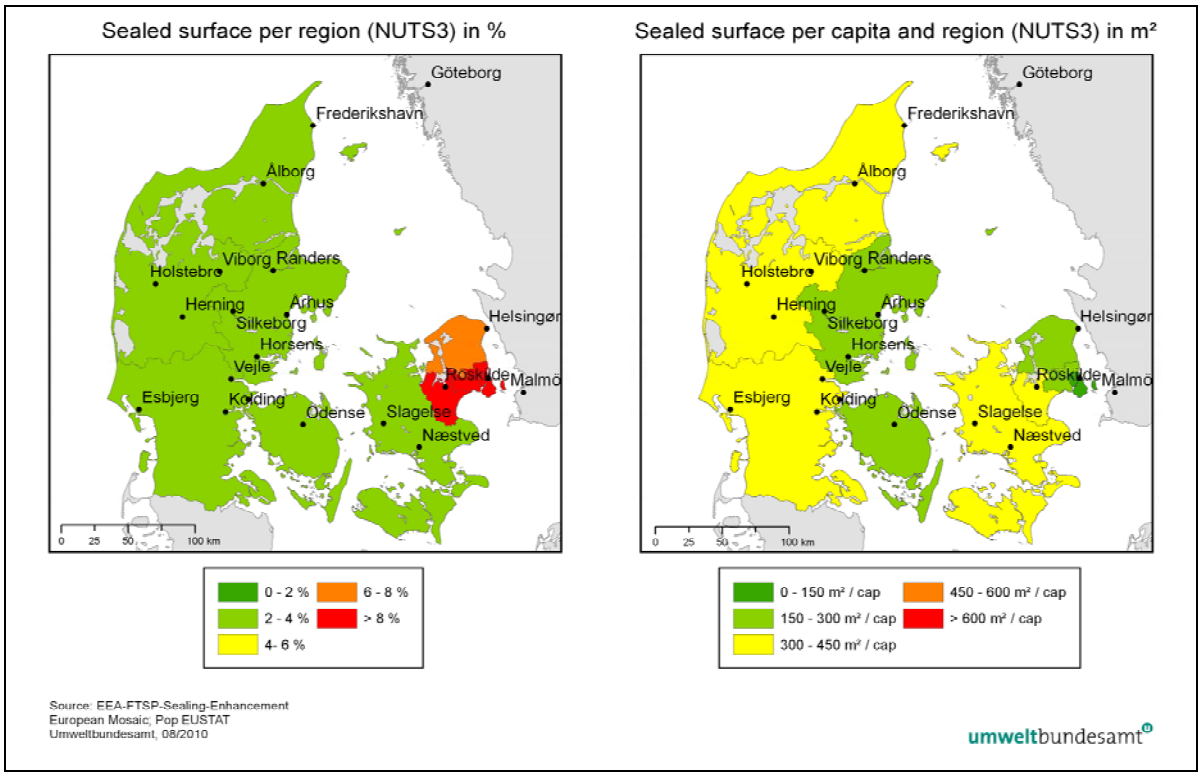

Fig. 22 Denmark: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Land use changes. The Danish State of the Environment Report [27] refers to a continuous decrease of nature and open land between 1965 and 2010, from 25 to 10 % of the national territory. In the same time also agricultural land decreased from 62 % to 57 % (see also Fig. 23).

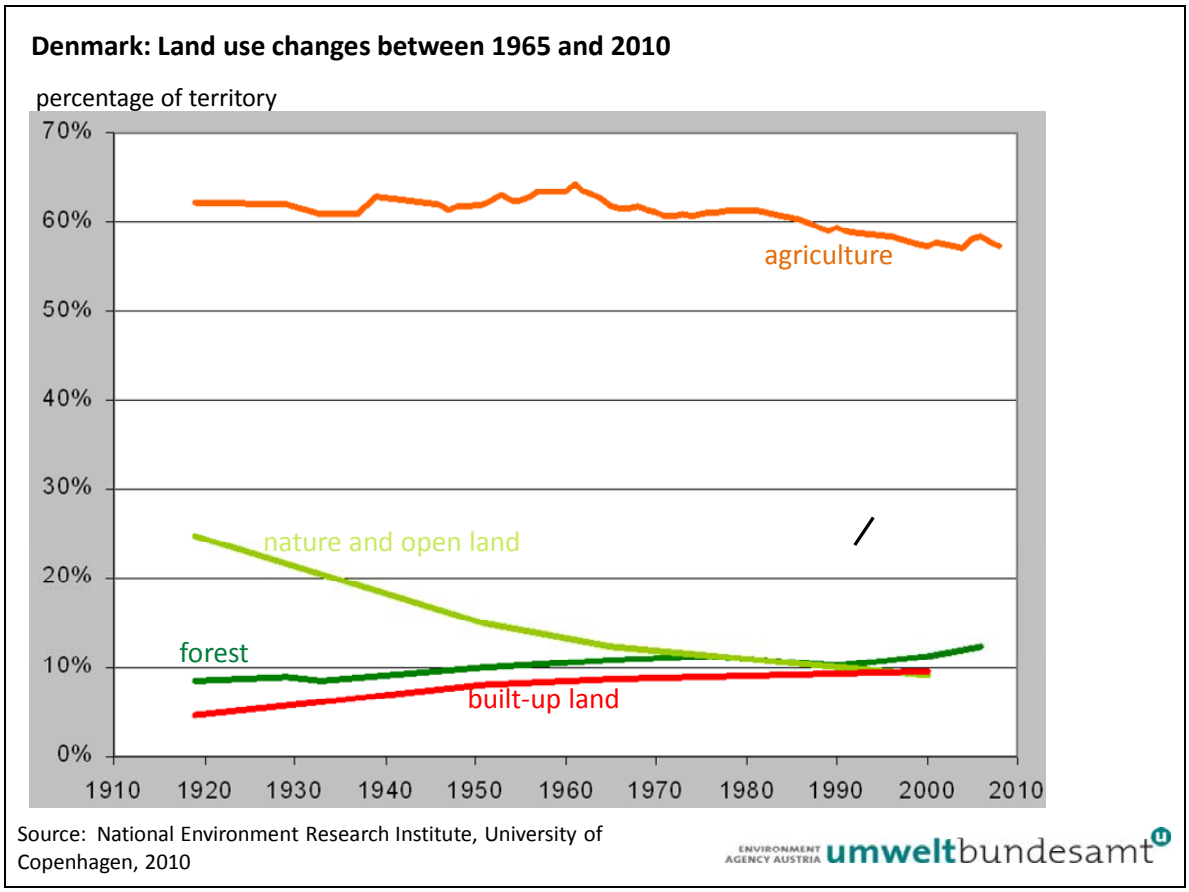

Fig. 23 Denmark: land use changes between 1965 and 2010
Source: Aarhus University, 2010 [27]
Note: comparable land use data exist since 1965.

2.7.2 Policies of interest

Spatial planning. The Ministry of the Environment is responsible for spatial planning. Key document of spatial planning is the *Planning Act*, which was enforced in 2001 and is continuously amended. The Planning Act decentralizes decision-making and promotes public participation.

In 2006 the national planning report "*The new map of Denmark*" was published. The document is the key programming document for national spatial planning. With regard to land take and soil sealing the following key objectives are of relevance [28].

- For the regions of Greater Copenhagen and Øresund the conversion and development of previously developed business sites and also entire business districts is defined as priority. Furthermore the increase and protection of green spaces, recreational areas and attractive urban environments is also defined as priority in order to establish prerequisites for attracting companies, jobs and employees.
- For the region of Sjælland the avoidance of undesired urban sprawl and the protection of recreational areas to reduce the demand for transport.

Protection of Nature. The Protection of Nature Act (Act No. 9 of 3 January 1992 with later amendments) focuses on the protection of beaches, lakes, watercourses, forests, ancient monuments, natural areas and international protection areas. This law amongst –others-

provides the basis for integrating nature management with other social objectives which is the precondition of sustainable development.

Sustainable development. The Danish strategy for physical planning from 2009 set a target to preserve a clear border between cities and countryside. This is taken further in the Danish strategy for sustainable development from 2009 stating: "The government prioritizes more compact cities and initiatives to avoid non-intended spreading of city areas into the open land."

2.7.3 Best practice

Strengthening of small city centres. The Planning Act encourages small retailers in the centres of Denmark's many small and medium-sized towns. The main rule of the Act is that general shops may not exceed 3,000 m² of floor space and specialty shops 1,500 m² unless there are "special reasons based on planning considerations". Three planning instruments are available (1) the delimitation of town centres and the centre of a city district in order to prevent urban sprawl; (2) imposing a maximum total floor space for each given area; and (3) imposing a maximum size on shops. Clear aim of this policy is to promote development in the numerous small and medium- sized towns and reduce the construction of large shops and shopping centres on green fields outside the largest cities [29].

Transnational spatial planning in the Øresund Region. The Governments of Denmark and Sweden have a joint aim of developing the Øresund Region into one of the cleanest urban regions in Europe [29]. Key objectives are

- to counteract urban sprawl and the depopulation of cities, to protect open stretches of landscape and undeveloped areas in coastal areas and to develop the green structure between and around cities and towns;
- to attempt to transform urban areas and increase density by reusing derelict urban land instead of building on green fields; and
- to give priority to urban development in locations with good access to public transport.

2.7.4 Conclusions

Denmark is highly affected by urban sprawl and soil sealing. The issue is well recognised at the political agenda and integrated in several policy documents. The issue of sustainable spatial development was established in 2001 with the Planning Act. Specific action lines are increasing the attractiveness of inner urban areas, revitalisation of run down industrial areas, activating centres of small cities, protection of landscapes, and delineating clear city borders.

2.8 Estonia

Geography. Estonia is a low, flat country with a long, shallow coastline of 1,393 km along the Baltic Sea and with more than 1,500 small islands dotting the shore. The two largest islands are Saaremaa and Hiiumaa, being favourite Estonian vacation spots. The country's highest point, Suur Munamägi (Egg Mountain), is in the hilly southeast and reaches 318 meters above sea level. About 40 % of the main land is covered by forests, and about one fifth by arable land. There are more than 1,400 natural and artificial lakes in Estonia. The largest of them, Lake Peipsi (3,555 km²), forms much of the border between Estonia and Russia. The most important rivers are Narva and Emajõgi.

Demography. Until the turn of the century Estonia suffered from heavy outmigration. Between 1990 and 2000 more than 12 % of the population were lost. Since 2000 a recovery from this trend can be observed, since population is only slightly shrinking.

2.8.1 Land take and sealing

Estonia is a small and very sparsely populated country. One third of the 1.3 million inhabitants live in Tallinn. Up to now Estonia has neither heavily sealed regions nor is the country affected by negative effects of sealing. However, artificial surface has been increasing rapidly since independence. The country side is characterized by very dispersed settlements. Urban citizens tend to own summer houses. Due to raising living standards the size of dwellings increased and there is a visible trend from urban flats to single family houses. This is the reason why the average amount of artificial surface per inhabitant is very high compared to other EU Member States[37].

Comparison with other EU member States. Between 1990 and 2006 the country was affected by a significant increase of annual land take, which more than doubled compared to the period 2000 to 2006. Before the turn of the century artificial surface increased on average by 1.8 m² per year and inhabitant, whereas after the century the average annual increase was at 4 m² per year and inhabitant. The amount of artificial surface per capita amounted to 700 m² in 2006, which is about 75 % higher than the EU average. Increase of land take between 2000 and 2006 was also considerable with 38 m² artificial surface per inhabitant.

[37] In 2006 EU average equals to 518 m² artificial surface per inhabitant, and in Estonia 700 m² per inhabitant.

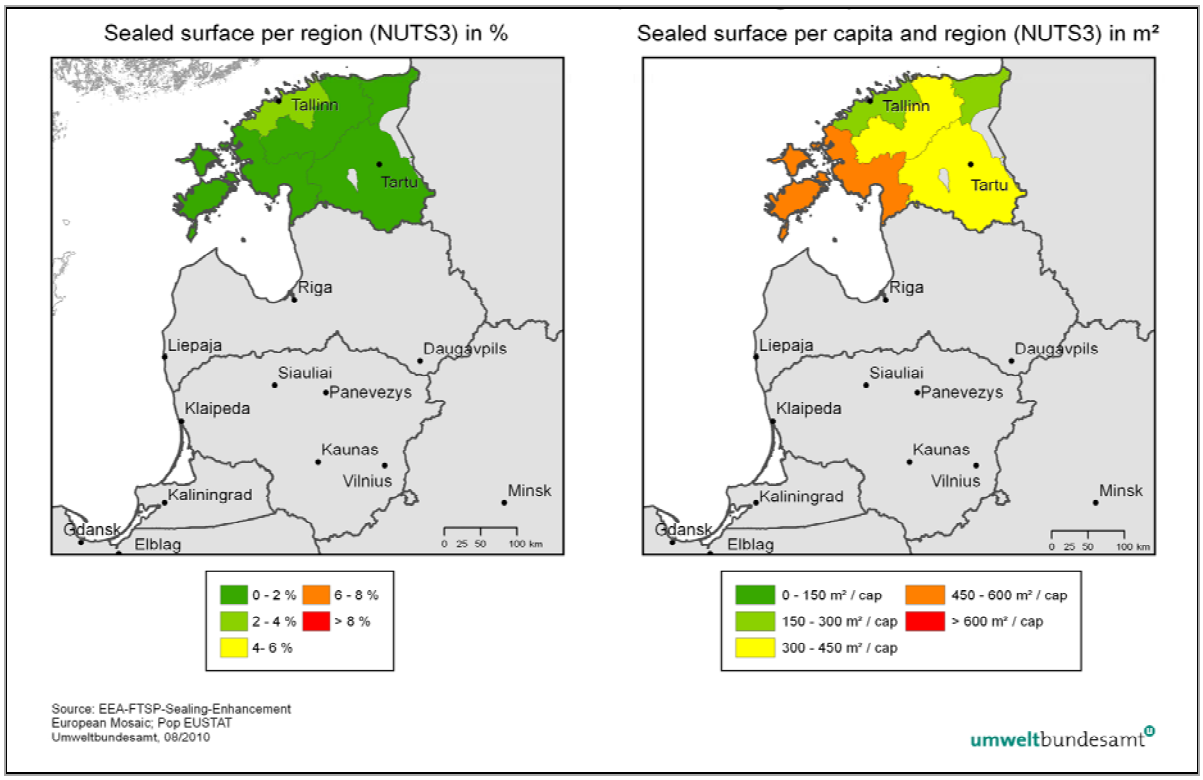

Fig. 24 Baltic Countries: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Monitoring. Until recently Estonia did not have a national observation system for land take changes. In 2010 a research project started with the objective to analyse Estonia's land take between 2000 and 2010 with more detail (going beyond the CORINE observations). Investigation areas are the counties Harjumaa and Pärnu. [30]

2.8.2 Policies of Interest

Spatial planning. Generally speaking there is a lack of spatial planning. After independence, the economic growth of the country, and hence deregulation and strengthening of the private sector were priority issues. Spatial planning is under the responsibility of the local authorities. The usually very small Estonian settlements do not have sufficient resources for regional planning; and planning unions do not exist. Therefore regional planning is mostly weak and negative effects of uncontrolled spatial development are currently not perceived.

Protection of agricultural land. The relative importance of agriculture in the Estonian economy has declined since the mid-1990s and the competitiveness of Estonia's agricultural sector is below the EU average, although a large part of the foodstuffs consumed in Estonia are grown in the country. Estonia carries a large stock of fallow agricultural land. Since independence the amount of active agricultural land decreased by 50 % (see also Fig. 25). One reason for this phenomenon is the fact that large shares of agricultural land were transferred to the original owners, many of which had no use of the land and did not work the land. Potential tenants who would be interested to lease the land are also scarce, since rural regions are heavily affected by out-migration. The Estonian Environmental Information Centre refers to a slight increase of active agricultural land in recent years [32].

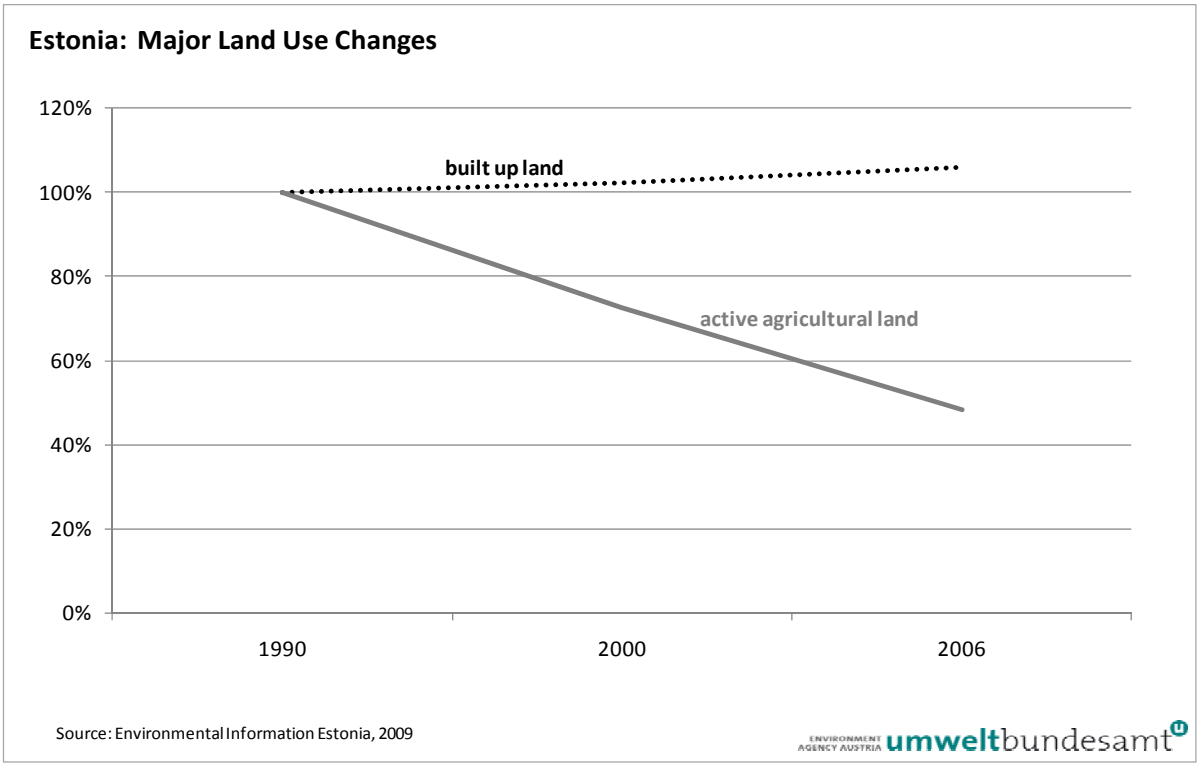

Fig. 25 Estonia: Major land use changes
Source: Environmental Information Estonia, 2009 [31]

2.8.3 Conclusions

Artificial surface is rapidly increasing in Estonia and it can be expected that this trend will continue for a while, since living standards are continually increasing and land is not scarce.

Negative effects of urban sprawl and soil sealing are not visible yet: Estonia has large amounts of fallow land, urban sprawl is not competing with agricultural land since most cities are situated on sandy soils. Flooding in urban areas is not an issue.

However, in 2010 a research group started to analyse land take in Estonia in more detail, the results can be expected in 2011.

Expected negative effects of increasing land take are high costs for maintenance of infrastructure (increasing road network for a small population) and increase in air emissions from private traffic due to growing distances.

2.9 Finland

Geography. With 337,030 km² Finland is the fifth largest country in Europe after Ukraine, Spain, Sweden, and Germany. Of this area 10% is water, 69% forest, 8% cultivated land and 13% other. Finland is the northernmost country on the European continent, one-third of the latitudinal extent of the country lie north of the Arctic Circle. Finland is divided into four regions: archipelago Finland, the coastal zone, the interior Finnish Lake District and upland Finland.

Demography. Finland numbers some 5.3 million inhabitants. Finland's population is growing continuously, but population growth slowed down after the turn of the century and is currently below the EU average. The average population density amounts to 16 inhabitants per square kilometre. This makes it, after Norway and Iceland, the most sparsely populated country in Europe. Population distribution is very uneven: the population is concentrated on small South-western coastal plain. About 60 % live in towns and cities, with one million living in Helsinki Metropolitan Area alone. The largest cities after Helsinki are Tampere (292,000 capita) and Turku (246,000). In Arctic Lapland, on the other hand, there are only 2 people to every square kilometre.

2.9.1 Land take and sealing

Finland is one of the most sparsely populated Member States in the European Union with only 5.35 million inhabitants living on a territory of 338,441 km^2. Average population density is only 17 inhabitants per km². The majority of the population lives in the South.

Comparison with other EU Member States. In the period 2000 to 2006 the growth of artificial area was below the EU average with 2.4 % and population growth was also moderate with only 1.6 %. The average sealing rate per capita is considerably high with 384 m² per capita, but due to the low population density and the enormous size of the country Finland is one of the least sealed member state.

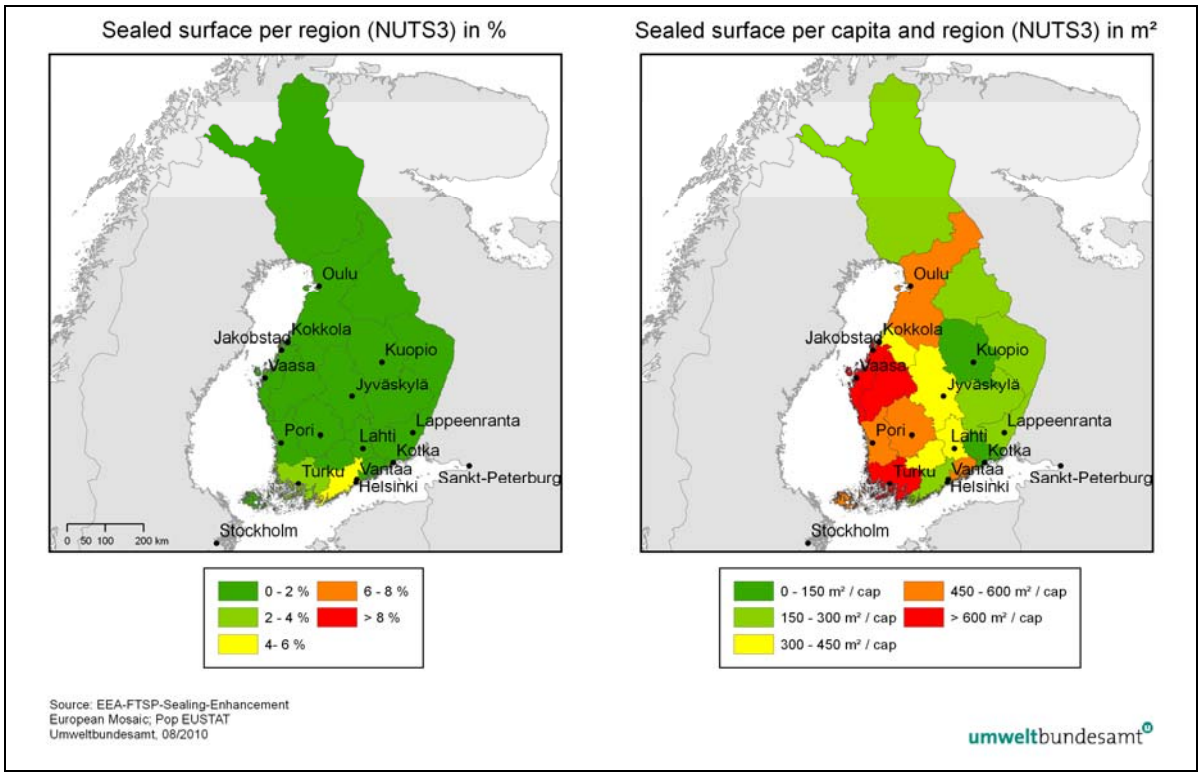

Fig. 26 Finland: Sealed surface per region

Source: Source: EEA, EUROSTAT

A specific feature of importance with regard to housing structures is the large number of summer cottages. Finland has currently more than 400,000 summerhouses and about 800,000 persons belong to a household who owns a summerhouse. The large number of summerhouses requires adequate transport infrastructure and contributes to soil sealing.

Between 1960 and 2005 the territory of urban areas increased by 50 % and the number of buildings within this territory by 150 %. Like in most other EU Member States there is a visible trend of shrinking household sizes due to an aging population. Between 1980 and 2006 the number of single person households doubled, whereas the number of four person households shrank by one third in the same period.

According to country experts urban sprawl in the Southern regions of Finland is expected to continue at the cost of rural areas and green land.

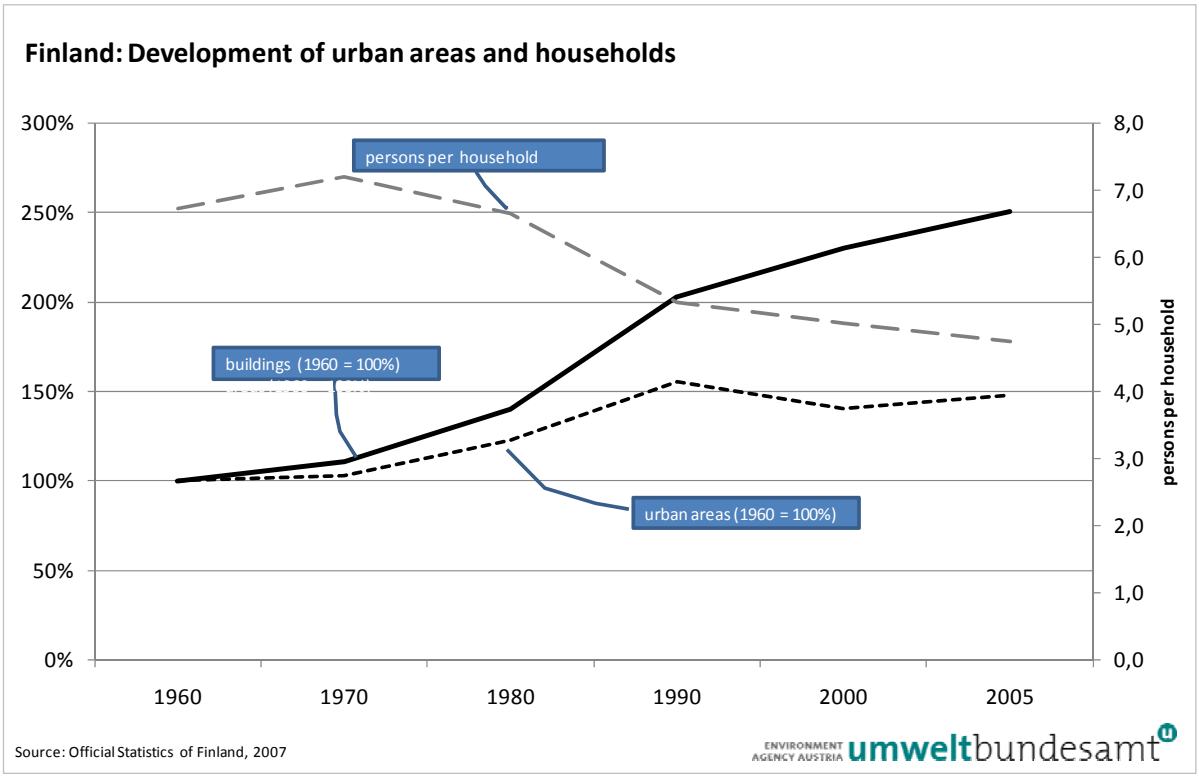

Fig. 27 Finland: Development of urban areas and households
Source: Official Statistics of Finland, 2007 [33]

2.9.2 Policies of interest

Finland has no specific national legislation or programme that would directly address the reduction of urban sprawl or soil sealing.

Urban planning. In the past 20 years urban sprawl has remarkably increased in the South of Finland. Rural municipalities competed with Helsinki and the private housing market boomed [34].

In the case of Helsinki urban planning puts emphasis on “green fingers”. Green recreational areas are preserved within the urban boundaries in order to increase the quality of urban life.

In single cases, contradicting positions occur between the Ministry of Environment and the local authorities. This was the case a few years ago when a shopping mall was planned at the outskirts of Helsinki. The development was stopped by the Ministry because the expected negative environmental effects: i.e. loss of soil and increase in traffic.

Monitoring. At the beginning of the 2000 years, a working group led by the Ministry of Environment developed a comprehensive set of indicators to monitor the living environment. Among these indicators the monitoring of “built area”, the “total amount of green areas within city boundaries” and “unpaved land areas” were suggested. A regular monitoring of these indicators was not realized later on, due to the high costs involved. However, awareness of the issues “urban sprawl” and “soil sealing” are growing and first surveys were initiated for the urban areas of Helsinki and Lathi [35].

Spatial Planning and Building. Legislation with regard to spatial planning and building does not specifically aim at reducing soil sealing or urban sprawl. However, the *Land Use and*

Building Act[38] which was enforced in 2000 and represents a clear commitment to sustainable spatial development, central objectives are (1) the protection of the environment and natural resources, (2) the accessibility of new developments in particular with regard to public transport, and (3) the social function (providing for the needs of various population groups) of buildings. The planning hierarchy is as follows:

- National level. The Land Use and Building Act is complemented by the National Building Code. More detailed regulations and controls on land use and construction are included in the Land Use and Building Decree.
- Regional level. Key planning instrument is the regional land use plan, which needs approval of the Regional Council and confirmation of the Ministry of Environment.
- Municipality level. Key documents are the local master plan, which is produced by the local authorities and the local detailed plans.
- Urban planning and reduction of urban sprawl.

2.9.3 Best practice

Sustainable building. In 1998, the Finnish government started an experimental sustainable building programme guaranteeing the framework for ongoing and new construction projects. Based on this initiative the City of Helsinki realised the development project "Eco-Viikki". Viikki is situated at the outskirts of Helsinki and is centred around biosciences research and education at the University of Helsinki. A new housing district was built according to the latest ecological standards and to meet the emerging housing needs of employees from the university and the science park. The project demonstrated how new living standards can be successfully realised with a minimal impact on the environment. The Eco-Vikki project included row houses and flats, respecting all types of household sizes and budgets. Due to combined parks and gardens all residents live in a green environment and have the possibility to grow their own vegetables. The average "sealed surface per capita" is much lower compared to standard single family houses, likewise the average energy consumption per household is extremely low [36].

38 Land Use and Building Act (132/1999) - Unofficial translation of the original Act, PDF format in Finlex, the Data Bank of Finnish Legislation

Fig. 28 Finland: Innovative housing "Eco Vikki", respecting low energy and low soil consumption.
Source: [159]

Research. In some Finnish research and pilot projects the issue of soil sealing is included as secondary topic. In "Action 6: Assessment of climate change and land use impacts in urban environments" of the project "Vulnerability assessment of ecosystem services for climate change impacts and adaptation" (VACCIA) soil sealing is investigated in the area of Helsinki and Lahti which commenced in the 1st January 2009. The project reports published so far are investigating the historical background and the reasons to explain the current status. More detailed data collection and assessments are ongoing [34], [37].

2.9.4 Conclusions

Loss of soil is discussed in Finland together with other topics such as climate change or urban living quality but not as a stand alone topic. This can be explained by the large size of the country. Land for new business locations and housing is still sufficiently available.

However, sustainable construction methods are of great importance in Finland. Due to shrinking household sizes and aging population there is an emerging trend to construct small "green" dwellings with good access to public transport.

2.10 France

Geography. France is the largest EU Member State. The landscape is diverse, with mountains in the East and South, including the Alpine peak of Mont Blanc (4,810 m) – the highest point in Western Europe. Lowland France consists of four river basins, the Seine in the North, the Loire and the Garonne flowing westwards and the Rhône, which flows from Lake Geneva to the Mediterranean Sea.

Demography. With an increase in population of 12 % between 1990 and 2006 France is among the most rapidly growing EU Member States. 62,79 million inhabitants are living on a territory of 547,030 km^2. Hence the average population density is 115 inhabitants per km². All of the 22 French regions are growing continually with the exceptions of Champagne-Ardenne and Franche-Comté.

2.10.1 Land take and sealing

Land Take and Sealing. The share of artificial surface is at 5.2 % and for sealed surface at 2.8 %, both values are slightly above the EU average. Artificial surface increased by 3 % between 2000 and 2006, corresponding more or less to average EU land take. With regard to soil sealing the agglomerations of Paris (Ile de France) and Lyon and the region Nord Pas de Calais are most affected. Highest growth rates of sealing and land take can be observed in the coastal regions adjacent to Marseille (Fig. 17).

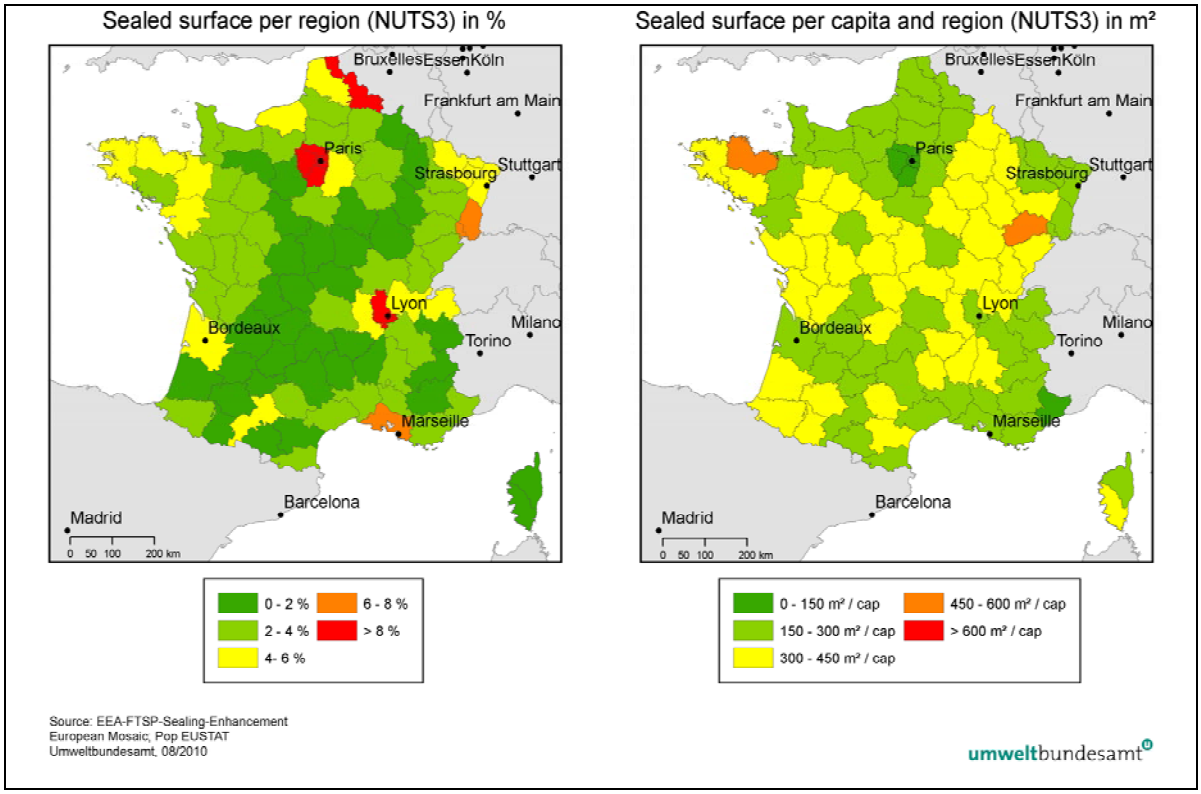

Fig. 29 France: Sealed surface per region
Source: Source: EEA, EUROSTAT

According to CORINE Land Cover data no disproportional growth of artificial surface can be observed, since population is growing faster than land take. However, the French Institute for

the Environment (IFEN, Institut Français de l'Environnement) published a more detailed assessment in 2006 referring to clearly alarming trends. IFEN concludes that between 1994 and 2004 population in metropolitan areas increased by only 5 % whereas land take amounted to 15 %. The assessment concluded that land take occurred mainly at the expense of arable land and that there was an urgent need to reuse already developed land for the construction of new infrastructure [38].

The latest environment report ("Environment in France in 2010") again highlights unsustainable trends with regard to land take [39].

- Growing distances in metropolitan areas. In the 71 main metropolitan urban areas the average distance of new buildings to the city centre was observed to have increased by more then 10 % between 2000 and 2008 compared to the period 1980 and 1990.
- Alarming land take in coastal areas. Between 2000 and 2006 land take was two times faster in coastal areas than in metropolitan urban areas. Artificial surface within the first 500 metres from the sea amounted already to 28 %.

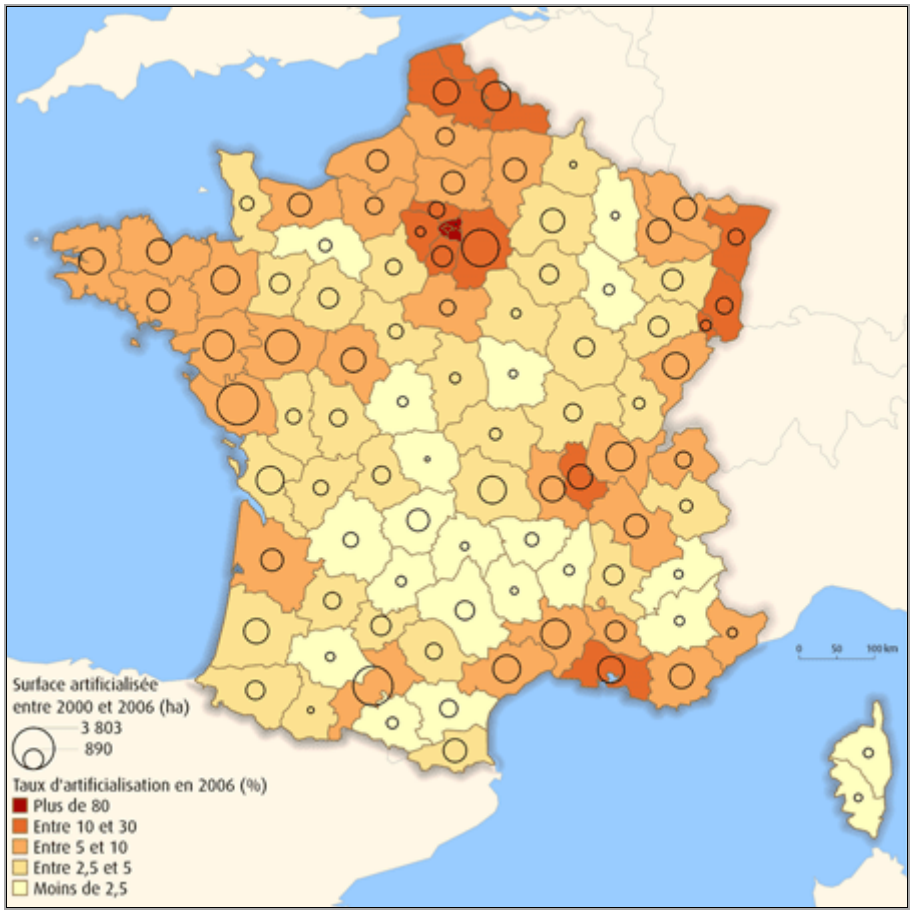

Fig. 30 France: Share of artificial surface per department
Source: IFEN, 2010

2.10.2 Policies of interest

In 2006 the **National Strategy for Sustainable Development** was subject to a revision process. A new sustainability objective with reference to land take reduction was defined,

namely *"to stop disproportional growth of artificial surface compared to population growth by constructing new infrastructure on already developed land"*[39].

The new strategy for sustainable development for the period 2010 to 2013 was completely streamlined to the "Grenelle Environment" (see below) and put more emphasis on the reduction of land take. In January 2010 a national sustainability indicator with regard to land take was defined and the reduction of land take was stipulated as national strategy for the conservation of natural resources, biodiversity and the fight against further landscape fragmentation [40].

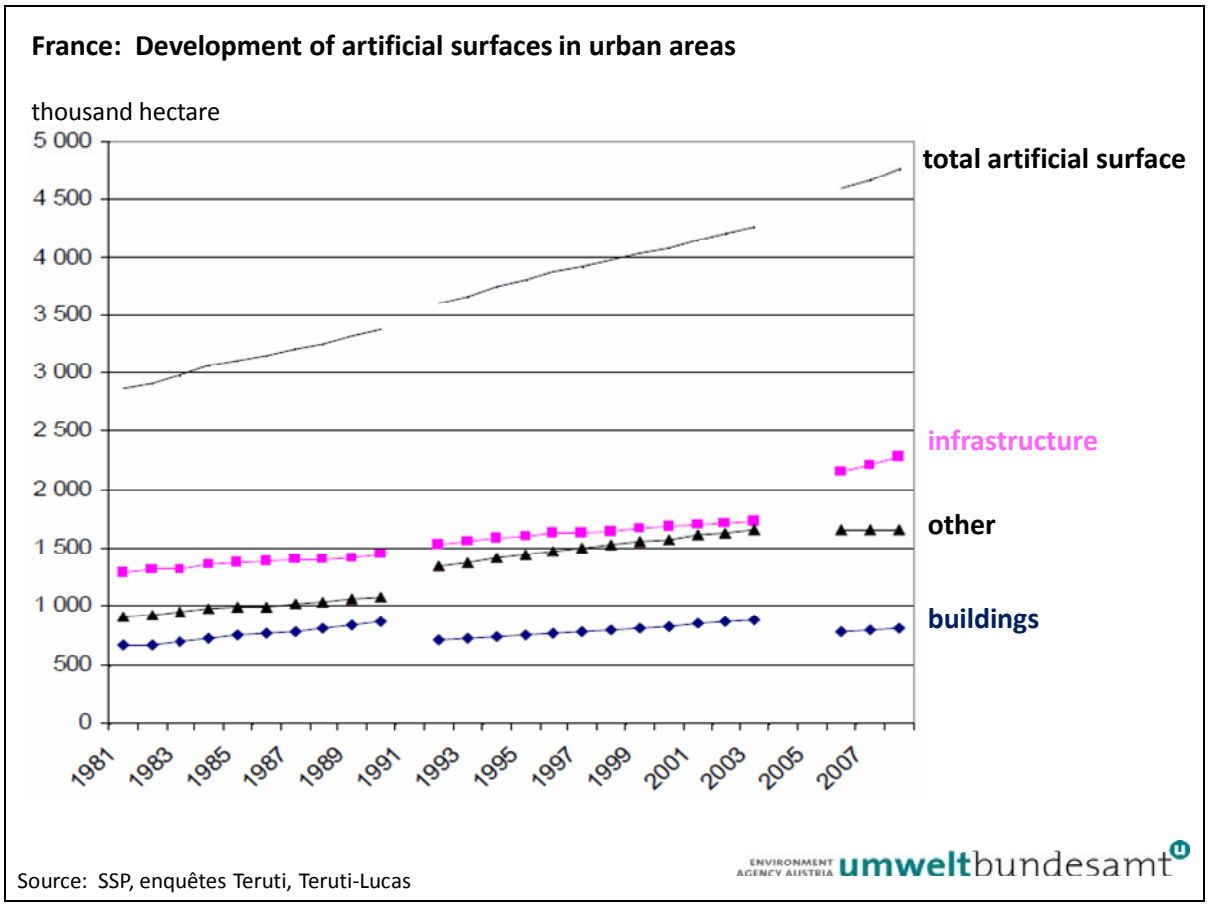

Fig. 31 France: Development of artificial surface in urban areas
Source: Enquetes Teruti, 2010

In July 2010 the law **Grenelle Environment** was enforced, with the objective to establish a comprehensive legal framework for the protection of the environment, reduction of energy consumption, improvement of economic and social stability. The policy framework is based on six major action lines, each of which is supported by legal requirements, pilot applications, and research. The most relevant action line for the reduction of land take and soil sealing is "*the improvement of energy standards of buildings and harmonization of spatial planning*"[40],

39 En France, la Stratégie nationale de développement durable révisée fin 2006 a notamment pour objectif de "veiller à freiner le rythme d'artificialisation du territoire, qui est actuellement plus rapide que la dynamique démographique, notamment en localisant les infrastructures sur les espaces déjà artificialisés".

40 Amélioration énergétique des bâtiments et harmonisation des outils de planification

which stipulates energy efficient urban structures by supporting inner urban development and avoiding further soil consumption. Specific projects, results or actions with regard to land take reduction shall be realised in this respect [41].

Brownfield redevelopment. France disposes of a network of more than 20 public land development agencies (EPF)[41], who operate at the regional but also at the local level. Key objective is to develop land for social housing. All EPFs have action lines focused on brownfield redevelopment and some have specific programmes for urban renewal (see also best practice EPF Nord-Pas-de-Calais). EPFs co-operate with local communities and provide funding for land development projects that match the specific local or national objectives [42].

2.10.3 Best practice

The public land development agency of Nord-Pas-de-Calais (Etablissement Public Foncier Nord-Pas-de-Calais) evolved from a brownfield development agency to a comprehensive land management agency focusing on (1) renewal of towns on themselves, (2) integration of soil pollution issues, (3) new development of social housing offer, (4) setting up a green and blue pattern on the regional territory and (5) controlling suburbanisation. Among the French regions Nord-Pas-de-Calais belongs to those with significant land use pressures almost comparable to those of Flanders. The sealing rate is on average above 6 % and the rate of artificial surface amounts to 14 %. Heavy industrial decline in the 1970ies and 1980ies has left an enormous legacy of industrial brownfield land and related economic pressures. Since 1991 the EPF Nord-Pas-de-Calais has developed 5,050 hectares of brownfield land with investments amounting to 176.6 million Euros.

The agency broadened their portfolio from mere brownfield redevelopment towards sustainable regional planning. In 2006 the agency concludes in their multiannual programme from 2007 – 2013 that 2,200 hectares agricultural soils are lost each year to infrastructure developments and that this trend shall be stopped. The 2007 – 2013 funding period shall allocate 383 million euro to three major thematic axes, namely (1) the development of social housing and urban renewal, (2) the realisation of large strategic brownfield redevelopment projects, and (3) the continuation of landscape protection with specific emphasis to connecting habitats and wetlands [43].

2.10.4 Conclusions

Land take and soil sealing affect above all metropolitan areas and coastal regions. Fragmentation of landscapes and growing distances of commuters gain more and more importance in French environment policy.

Awareness of the problem is growing continually as can be seen in the definition of a national sustainability indicator for land take. The recently issued law Grenelle Environment stipulates inner urban development and foresees harmonisation of spatial planning procedures. However, the law was only recently published and effects are not yet visible.

41 Etablissements Publics Fonciers: http://www.epfl.fr/sites/internet/epffrance/Pages/default.aspx

2.11 Germany

Geography. Germany covers an area of 357,111 km^2 and comprises 16 Federal States. Major landscapes are: the North German Plain, the low mountain ranges, the foothills of the Alps and the Alps themselves. In 2008 land cover shares were documented with 52.4 % agricultural land, 30 % forest, 13 % settlement and traffic area, and 2.4 % expanses of water [44].

Demography. With 81.8 million inhabitants (Nov.2009), i.e. 229 inhabitants per km^2, Germany is the most densely populated country in the EU. Between 1992 and 2004, the area of settlement for private households increased by 22.1% (i.e. 61 ha per day). At the same time Germany´s population has not grown for years and is even declining in some regions. Forecasts predict that this demographic trend will continue in the long term.

2.11.1 Land take and sealing

Sealing and Land Take. The amount of artificial surface per capita is about 10 % below the EU average with 365 m² per inhabitant. This can be explained with the high density of urban agglomerations. In the period 2000 to 2006 the growth of artificial surface was slightly faster than population growth. The index “artificial surface per capita” increased by 1.3 %. In 2006 the amount of sealed surface per capita amounted to 249 m² which is about 10 % above the EU average.

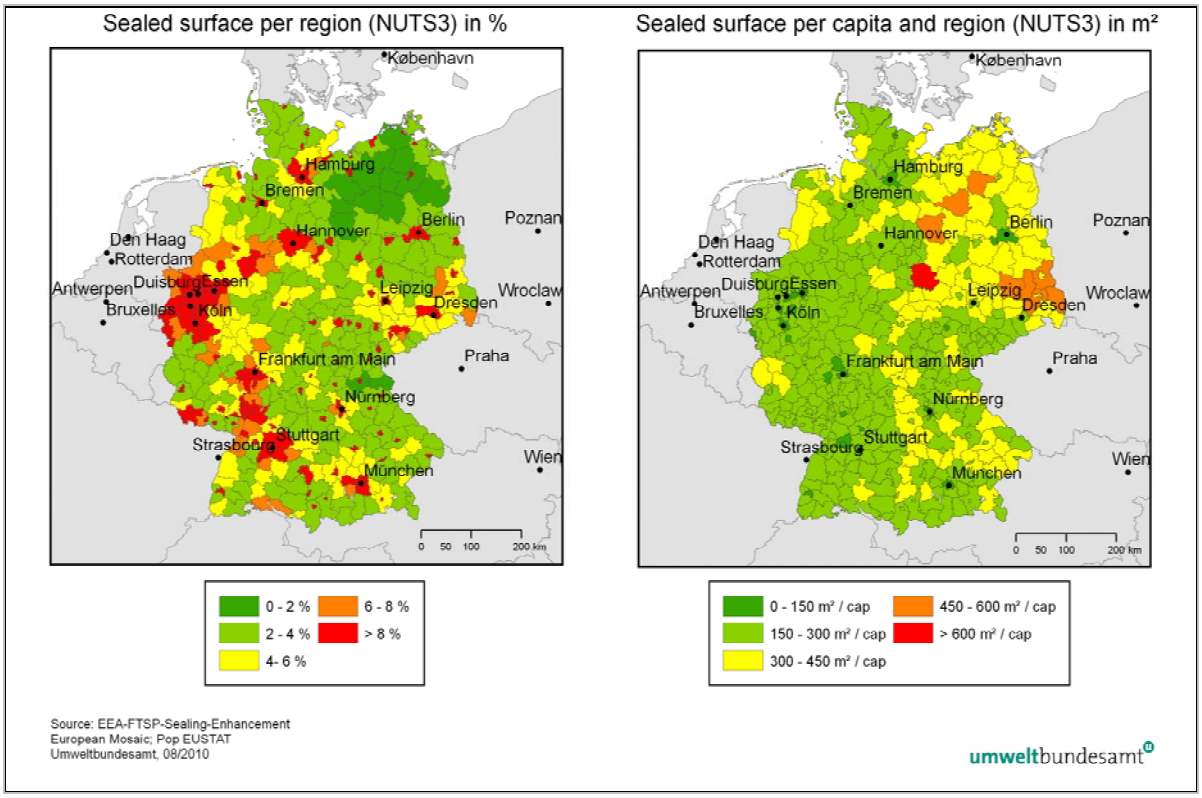

Fig. 32 Germany: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Many German regions are heavily affected by urban sprawl and soil sealing; in particular the Ruhr basin Rarebit – one of the largest urban agglomerations in the European Union – and

the South-western parts of Germany. On the other hand many regions in the East of Germany are highly affected by shrinking population and considerable amounts of abandoned land with high sealing rates. In the past decades a continuous loss of agricultural land, especially in the surroundings of big cities, was observed. The main reason for this development is the permanent increase of settlement and traffic areas which comprise buildings and surrounding open areas, roads, paths, tracks, recreation areas, sports pitches, operative areas as well as cemeteries. The continuous increase in land take for settlement and traffic areas and consequently the dissection of land, leads to a loss of natural cycles and to a fragmentation of habitats of larger species. The sealed surface is estimated[42] at about 46% of the settlement and traffic area. This is about 6 % of the country's total area. In the past 60 years settlement and traffic areas increased more than twice covering an area of about 46,000 km^2. This almost comes up to the size of Lower Saxony.

Due to the different economic and social systems of East and West Germany land take developed in a very different manner. This difference arose from economic interests that could develop in a free market economy whereas in Eastern Germany land take from mining of brown coal was the main factor. Tab. 3 shows the increase in land take between 1960 and 1989 and 1993-1997. Statistical for the period 1989 to 1992 could not be identified.

Tab. 3 Germany: Growth of settlement and traffic area between 1960 and 1997 in East and West Germany.
Source: [45]

1960-1989	**East**	**West**	**Germany (total)**
Annual increase in ha	6,800	35,400	42,200
Annual increase in % of total area	0.70	1.74	2.44
Daily increase in ha	19	97	116
1993-1997			
Annual increase in ha	11,500	33,250	44,750
Annual increase in % of total area	1.36	1.08	2.44
Daily increase in ha	31	91	122

Between 1960 and 1989 the increase in settlement and traffic area in former West Germany was about 2.5 % higher than in former East Germany whereas in the period of 1993-1997 land take in East Germany was higher. In the 1990ies the reunion stimulated the building industry and land take increased. In Eastern Germany building on greenfield sites was encouraged by the available funding systems and resulted in uncontrolled urban sprawl: private residential buildings, shopping centres, industrial estates, roads and rail tracks. The decrease and later stagnation of the economic growth resulted in a reduction of land take from 2001 on. Between 2000 and 2006 the increase in artificial surface was slightly higher in West Germany (1.8 %) compared to the former East (1.2 %) [45].

For about 20 years land take[43] is being monitored in Germany. The monitoring refers to the average daily land take for a reference year. In the period 2004 to 2007 land take was observed to amount to 113 hectare per day. For the succeeding period a slight decrease of the average daily land take was observed with only 104 hectare per day. Fig. 33 shows the area

42 LABO – Länderarbeitskreis für Bodenschutz

43 Land take refers to the conversion of green land to building land for settlement areas and traffic areas. In Germany about 46 % of these areas are actually sealed.

(ha) sealed per day in the period 1992 – 2008.

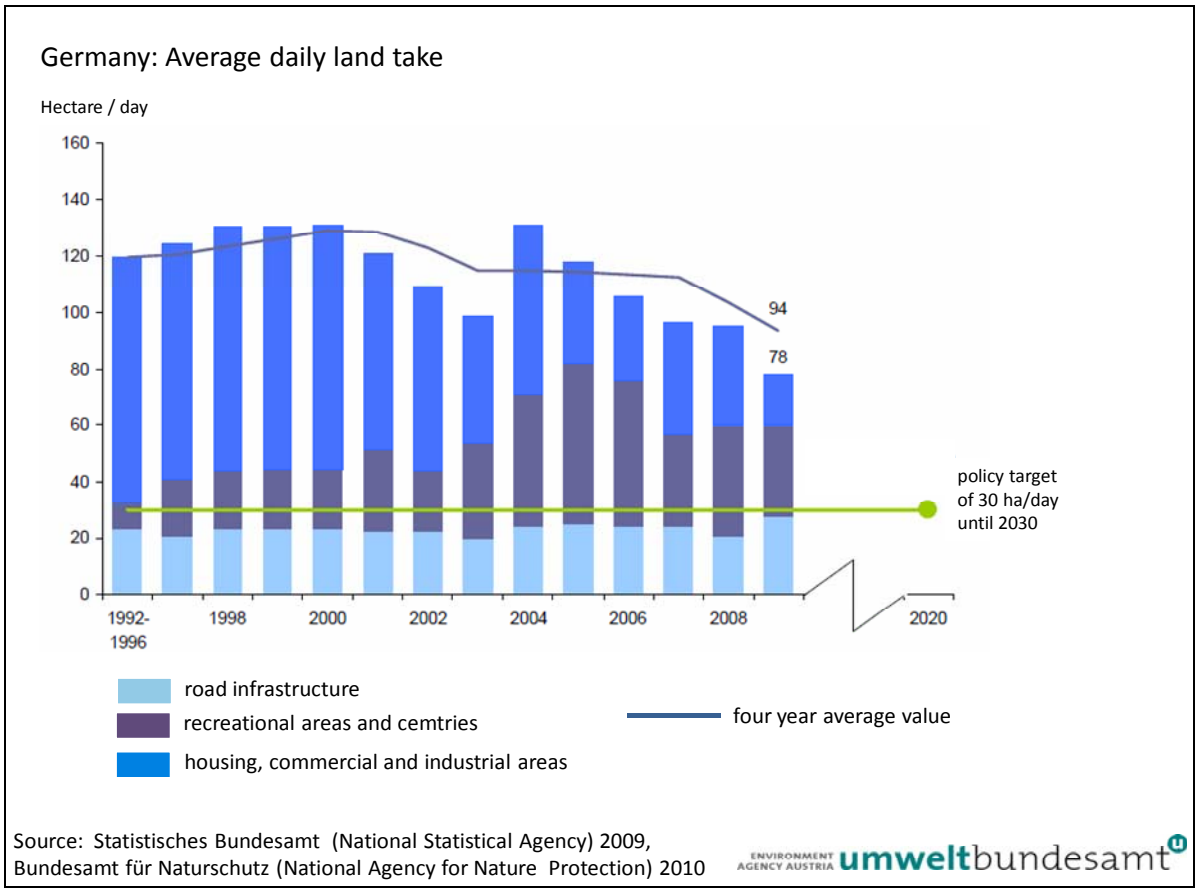

Fig. 33 Germany: Average daily land take, 1992 - 2009
Source: [46]

2.11.2 Policies of interest

Spatial planning. In Germany there are four planning levels: the national, the Federal State the regional, and the municipal level. The Spatial Planning Act (Raumordnungsgesetz – ROG 1997) provides the framework for spatial order and planning. The Federal States make this framework operational and have their Planning Act. Each Federal State consists of several planning regions, which are responsible for the preparation of specific regional planning guidelines. Despite this framework at the higher planning levels, the local level still has considerable power in Germany. The building law (Baugesetzbuch – BauGB 2004) regulates the land use planning at the local level. The current version of this legal framework contains a soil conservation article and a powerful link to the Nature Conservation Act[44], which requires the compensation of environmental impacts in the case of building measures (see also chapter on compensation measures).

National policy target for land take reduction. In 2002 the national target for the reduction of land take was published in the *Strategy for Sustainable Development*; the target refers to a reduction from 100 to 30 hectares per day in the period 2002 to 2010 [47]. To reach this target considerable efforts have been undertaken, of which the most remarkable are described

[44] Bundesnaturschutzgesetz - BNatSchG 2002

below:

- Recommended Measures. In 2004, the German Council for Sustainable Development (CSD) published recommendations on how to achieve the "30 ha target". The recommendations referred to a combination of instruments, including fiscal-economic, regulatory and planning tools. Major objective of the process is to stop the increasing fragmentation and expansion of cities and villages and to support their "inner" development.
- Specific Research. The research programme REFINA "Research for the Reduction of Land Consumption and for Sustainable Land Management" (→ see also page 198) was launched in 2006 and is part of the German National Strategy for Sustainable Development. The programme is jointly funded by three ministries (Education and Research, Transport, Building and Urban Affairs, and Environment, Nature Conservation and Nuclear Safety). More than 100 projects in about 50 research collaborations and individual projects are involved in the REFINA research programme. The REFINA funding budget amounts to € 22 mio. Euro. Funded projects have developed innovative concepts for reducing the rate of land take and for encouraging sustainable land management. Special emphasis is put on inner urban development and reuse of brownfield sites.
- Policy Evaluation. In 2007 the Council for Sustainable Development reviews Germany's policy to reduce land take. Key recommendations are the implementation of powerful economic instruments and to establish a nationwide concept for integrated land management (commitment of all involved sectors).[48]
- Implementation of powerful economic measures needed. In 2009 the Commission for Soil Protection concludes that so far implemented measures to reduce Germany's land take were not sufficient to reach the "30 ha target" and recommends the implementation of tradable development certificates (see also chapter "Compensation systems"). A nationwide pilot is currently being planned which shall include 40 municipalities (including major cities) from all over Germany and operate for four years [49].

The 16 German Federal States have a high degree of autonomy and have realised different strategies and concepts to reduce their annual land take. In the following section the concepts of two Federal States with very contrary challenges are described in more detail.

Land Management in Baden-Württemberg. With 35.752 km^2 and 10.7 million inhabitants Baden-Württemberg is the third largest Federal States. Baden-Württemberg is among the economically strongest and most competitive regions in Europe. Especially as far as industrial technology as well as research and development are concerned, Baden-Württemberg is the most innovative region of the EU. The unemployment rate of 4.8 % (February 2009) is the lowest of the whole country. Based on the GDP (gross domestic product), Baden-Württemberg is one of the wealthier regions of the EU with an index of 128.8 (Germany 115.2, EU27 100).

Between 1950 and 2001 residential- and traffic area increased by 125%, whereas population growth amounted to only 65 % (see also Fig. 34). Presently population is declining, However in 2008 still 8.2 ha per day were subject to land take.

In 2004 an alliance[45] to reduce the annual land take in Baden Württemberg was initiated. The alliance was signed by all relevant policy makers and representatives from industry and

[45] The alliance „Gaining Land in Baden-Württemberg" (Flächen gewinnen in Baden Württemberg") was initiated by the Ministry of Environment in 2002. http://www.uvm.baden-wuerttemberg.de/servlet/is/56507/

trade. Overarching principle of the alliance is to integrate efficient land use in all sectors and to create awareness for soil resources, specific action lines were [52]:

- Monitoring and progress evaluation. Land take is monitored and analysed on a regular basis. Results and their interpretation are being published annually by the Statistical Survey of Baden Württemberg.
- Public awareness. A broad public campaign was carried out to inform decision makers and the broad public about the negative impacts of land take and soil sealing and the potentials to avoid them.

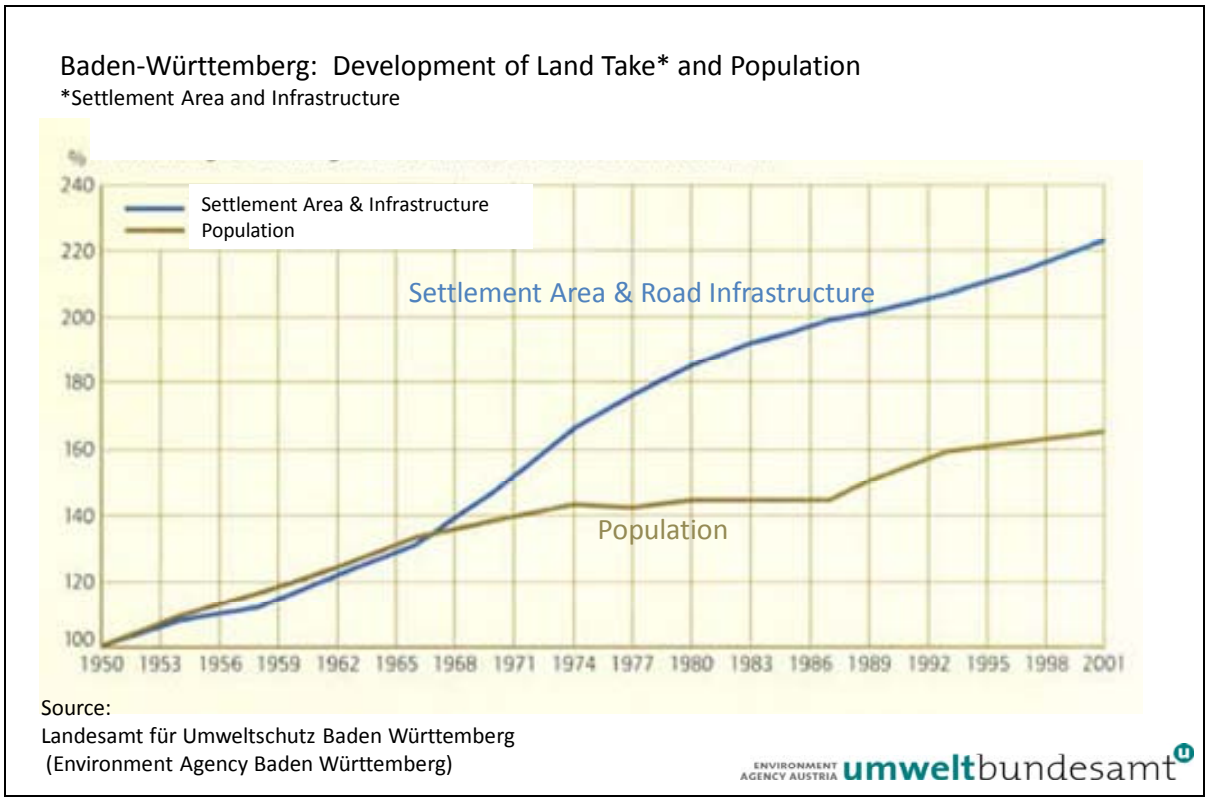

Fig. 34 Baden-Württemberg: Development of land take and population between 1950 and 2008
Source: Environment Agency Baden Württemberg

- Legal action. The planning law was adopted in full consideration of reducing land take, this included among others the set-up of comprehensive regional planning and the unification of the competency for the approval of land-use plans. The regional plans have to be produced according to sustainable land management rules, respecting (1) the protection of valuable soils, (2) the strengthening of “inner-development”, and (3) the issuing of development permits only according to approved land requirements
- Protection of high quality agricultural land. The best agricultural land receives better protection. Agricultural land of high quality has to be integrated in the regional plans as areas with high vulnerability and special protection.
- Strengthening of inner urban development. Revitalization of city centres and the reuse of brownfields have priority in regional planning. Specific funding is provided for new developments inner-city areas. As far as the traffic sector is concerned priority is to expand existing roads rather than building new ones and the recultivation of no longer

used roads. Every 2 years, Baden-Württemberg is allocating a brownfield recycling award. The projects submitted have to be realized on brownfield sites between 2005 - 2010 in Baden-Württemberg.

- Rural Development. The Rural Development Programme (ELR – Entwicklung ländlicher Raum) promotes the development of villages in Baden Württemberg. Specific emphasis is put on improving living and working conditions in rural areas, to counteract migration to large metropolitan areas, and to strengthen the centres of small rural cities by reusing existing buildings and brownfield sites. An outstanding project within this funding programme was the MELAP project; 13 model villages committed themselves to avoid new development on green field sites for a period of six years (see also page 90) [54].

Conclusions. Baden Württemberg is one of the wealthiest and densely populated regions in Europe. Increasing urban sprawl and soil sealing were clearly perceived as unsustainable trends. At the turn of the century the government of Baden Württemberg initiated a comprehensive system to reduce the annual increase in land take, including a revision of the planning law, awareness campaigns, incentives for inner urban development, and research efforts.

Statistical observations of the annual land take show a clear declining trend for the period 2001 to 2008. However, in 2008 the daily land take was documented with 8.2 hectare per day which is still far above the anticipated national sustainability target, requiring an index of 3.6 hectare for Baden-Württemberg (Fig. 35).

Demographic forecasts predict no significant population growth and a shrinking number of new households per year. Already implemented measures are being continued and are expected to show clearer impacts from year to year.

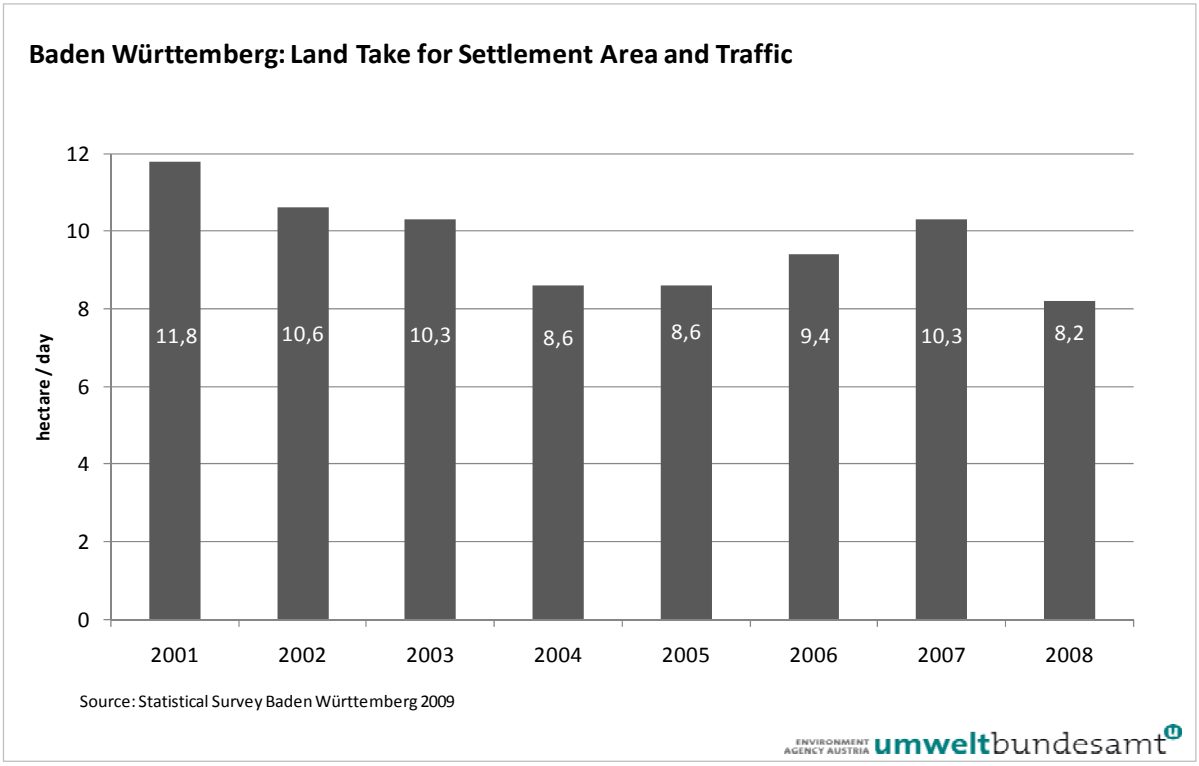

Fig. 35 Baden-Württemberg: Land take for settlement areas and traffic
Source: Statistical Survey Baden Württemberg, 2009 [55]

Land Management in Saxony. Saxony is one of the smaller German Federal States, with 4.3 million inhabitants and a territory of 18,413 km². Saxony´s number of inhabitants has been decreasing due to migration over the last decades especially in the rural parts of the county. Only in Dresden and Leipzig the population is growing and is expected to grow until 2020. After the German reunion most industrial enterprises were closed and most coal mines and power plants were shut down. However, the economic situation is improving in Saxony; the unemployment rate decreased since the turn of the century and is currently below 12 %[46].

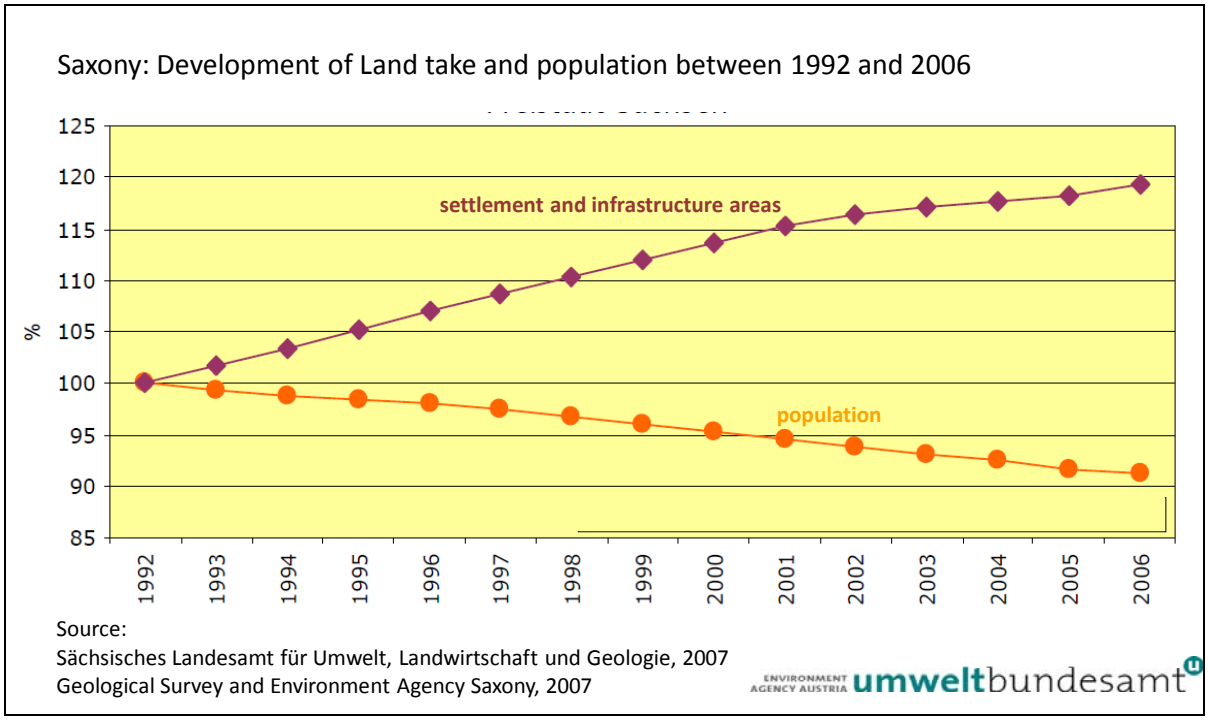

Fig. 36 Saxony: Land Take for Settlement Area and Traffic
Source: Statistical Survey Baden Württemberg, 2009

Saxony is confronted with several economic and geographic challenges, of which the most serious are a very slowly growing economy, large amounts of brownfield land, serious flood risks in very populated areas, and shrinking rural regions.

Saxony disposes of 18,000 hectare of abandoned land originating from industry and military, of which about 40 % are situated in inner urban areas. Derelict areas in inner urban districts put enormous pressure on city planning; they enhance migration to suburbs and social frictions.

In Saxony a broad range of measures were implemented to reduce the annual land take. They have different objectives ranging from flood prevention to restructuring of city centres.

46 Employment Statistics, Agency for Employment (http://www.arbeitsagentur.de)
Original name: Bundesagentur für Arbeit

- Land Development Plan Saxony. The Plan was enforced in 2004 and represents the general framework for land development in Saxony; it includes mandatory principles, which have to be respected by all planning authorities. Major objective is the reduction of land take by (1) realising new developments within existing settlement boundaries, (2) and preliminarily on already developed land (in particular brownfield sites), and (3) to implement greening measures on brownfield sites which cannot be reintegrated in the real estate market. Furthermore, the plan requires that large commercial centres (shopping malls) have to be developed in inner urban districts to avoid new traffic streams and urban sprawl. New settlements of industry have to be built on brownfield sites and/or in already existing industrial areas. Co-operation of municipalities to jointly invest in the development of new commercial or industrial areas (in particular on brownfield sites) is highly encouraged. The allocation of "protected green land" in the local zoning plans is mandatory. This category must not be converted into building land and includes agricultural soils of high quality, recreational zones in urban areas, and retention areas [51].
- Flood Risk Prevention. In the past Saxony was seriously affected by floodings of the rivers Elbe and Moldau. In particular in 2002 many settlements along the river Elbe were severely flooded and damaged. High soil sealing rates and lack of retention areas enhanced the damages. Saxony reacted with an adoption of the land development rules and the enforcement of the novel Saxon Water Act; (1) building activities in flood risk areas are banned, (2) retention zones were extended, (3) soil sealing rates in flood risk area are being monitored with the aim to avoid any increases in sealing, and (4) desealing of abandoned land is encouraged.

  The city of Dresden puts special emphasis on the preservation of flood retention areas; the soil sealing rate within the city boarder is continuously monitored. Desealing measures are promoted and have to be implemented as compensation for new developments – based on the national nature Conservation Act (see also page 181).
- Brownfield Redevelopment. In the funding period 2001 – 2006 of the European Funds for Regional Development (EFRE) Saxony implemented a specific brownfield redevelopment programme. The EFRE Funds supported funded the reuse of more than 100 former industrial sites with about 64.2 Mio. €. Most sites were demolished and subject to greening measures since no commercial use opportune [50].

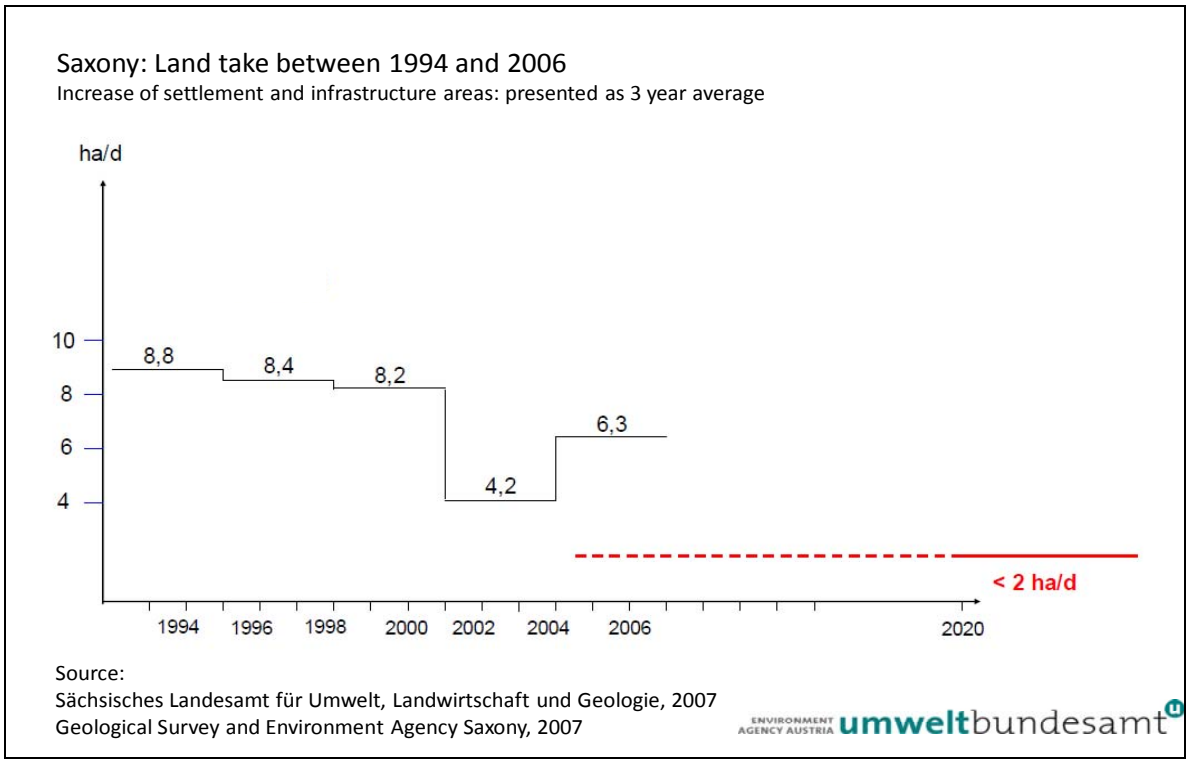

Fig. 37 Saxony: Land Take for Settlement Area and Traffic
Source: Geological Survey and Environment Agency Saxony, 2007

Conclusions. Since the early 1990ies Saxony has been affected by a considerable population loss and an enormous amount of abandoned post-industrial and post-military land. A declining trend for land take can be observed since 1994. Since 2006 land take is documented with about 6 hectare per day which is still far above the anticipated policy target of 2 hectare per day (to be reached until 2020).

In 2007 the Saxon Environment Agency and Geological Survey assessed the state of annual land take in Saxony and published recommendations for the future [55]. The assessment concludes that implemented measures like the new land management plan, awareness campaigns, and the brownfield revitalization programme made a visible impact and led to a reduction of the annual land take. However, without a revision of the current funding system (in particular for new industrial locations) and without clear quantitative limitations for development land –the Saxon policy target for land take cannot be reached.

2.11.3 Best practice

Several outstanding research projects and initiatives have been realised since publication of the “30 hectare target” for the reduction of land take, a few of which are described below.

Rural development. The MELAP[47] project was funded within the rural development programme of the Federal State Baden Württemberg. Over a period of six years 13 model villages committed themselves to avoid new developments on green field sites. The project

47 Original title „Modellprojekt Eindämmung des Landschaftsverbrauchs durch Aktivierung des innerörtlichen Potenzials“; translation „Reduction of Land Take by Activating Inner Urban Development Potentials“

was based on the assumption that in the concerned villages sufficient developed land was available to meet the needs of the inhabitants and that no further green land needed to be developed.

In practice underused land in inner urban areas is not easy to develop. The land is in most cases very expensive, or not available because owners are not willing to sell, or existing buildings do not meet current standards and are difficult to renovate. The project MELAP aimed at overcoming these challenges. Key results showed that a kick-off funding from public resources is needed to start projects in rural areas, in particular in village centres. The funding was between 0.6 and 1.5 mio. Euro per community. Experiences gained from the MELAP project were incorporated in the new guideline for rural development, which led –amongst others- to a considerable improvement of the funding conditions for the restructuring and reuse of former agriculturally used estates.

Circular Land Use Management[48] represents an integrative policy and governance approach towards land use and is based on the principle "avoid –reuse –compensate". The prior, systematic objective of Circular Land Use Management is to fully utilise all potentially available, previously used sites. In this system, the use of virgin land is tied to a very limited set of conditions. Research according to this principle was simulated in several German planning regions (Stuttgart, Mölln, Rheinhessen-Nahe, Duisburg and Nordthüringen) in the period 2004 to 2007and was part of the programme for Experimental Housing and Urban Development. A series of new instruments and guidelines were developing for planners and decision makers to support the Circular land Use principle.

2.11.4 Conclusions

Many German regions are heavily affected by urban sprawl and the negative effects of soil sealing. In 2002 the German government published a national policy target to reduce the annual land take by 70 % until 2020. So far apparently the measures taken have not been sufficient. As figure 32 shows the average daily land take has remained more or less constant over the past years, showing that up to 2010 not much has been achieved in terms of decreasing the daily land take. Hence Germany is still far from reaching the 30-ha-target as the statistics show a continuous trend in land consumption. All German Federal States implemented measures to reduce their land take. Due to the strong independency of the German Federal States different approaches were adopted in this respect. In parallel the government launched a large research programme (REFINA) to support this policy. In 2007 the reduction of land take and implemented measures were evaluated [48]. The evaluation report concluded that although a decreasing trend in annual land take was observed powerful measures were still necessary to reach the "30 hectare" policy target. The report stated that the existing taxation and funding systems were in many aspects too controversial for the reduction of annual land take[49]. Either a binding quantitative limitation of development land was needed or clear economic incentives for inner urban development.

In 2009 the Commission for Soil Protection recommends the implementation of tradable development certificates (see also "Trading Systems, page 185). A nationwide pilot is currently being planned which shall include 40 municipalities (including major cities) from all over Germany and operate for four years.

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48 Original title „Fläche im Kreis", see also http://www.flaeche-im-kreis.de/english_version.phtml

49 The income of municipalities highly depends on the number of inhabitants and business companies. This principle more or less governs land take for settlements and transport.

2.12 Greece (short country profile)

Geography. Greece belongs to the most mountainous countries in Europe with about 80 % of the territory covered by mountains. Central and Western Greece contain high and steep peaks dissected by canyons and other chalky formations. Greece has about 160 islands, of which less than half are inhabited. Greece's agriculture is marked by a lack of natural resources and therefore concentrated in the plains of Thessaly, Macedonia, and Thrace, where corn, wheat, barley, sugar beets, cotton, and tobacco are harvested. Approximately 70 percent of the land remains uncultivated because of poor soil or because it is covered by forests.

Demography. Population growth between 2000 and 2006 amounted to 2 %, which corresponds to about the EU average. About 60 % of the total population lives in urban areas. The Population density is 86 people per km². Major urban agglomerations are the Athens region, where about one third of the total population lives, Thessaloniki in the North, and Patra in the South West.

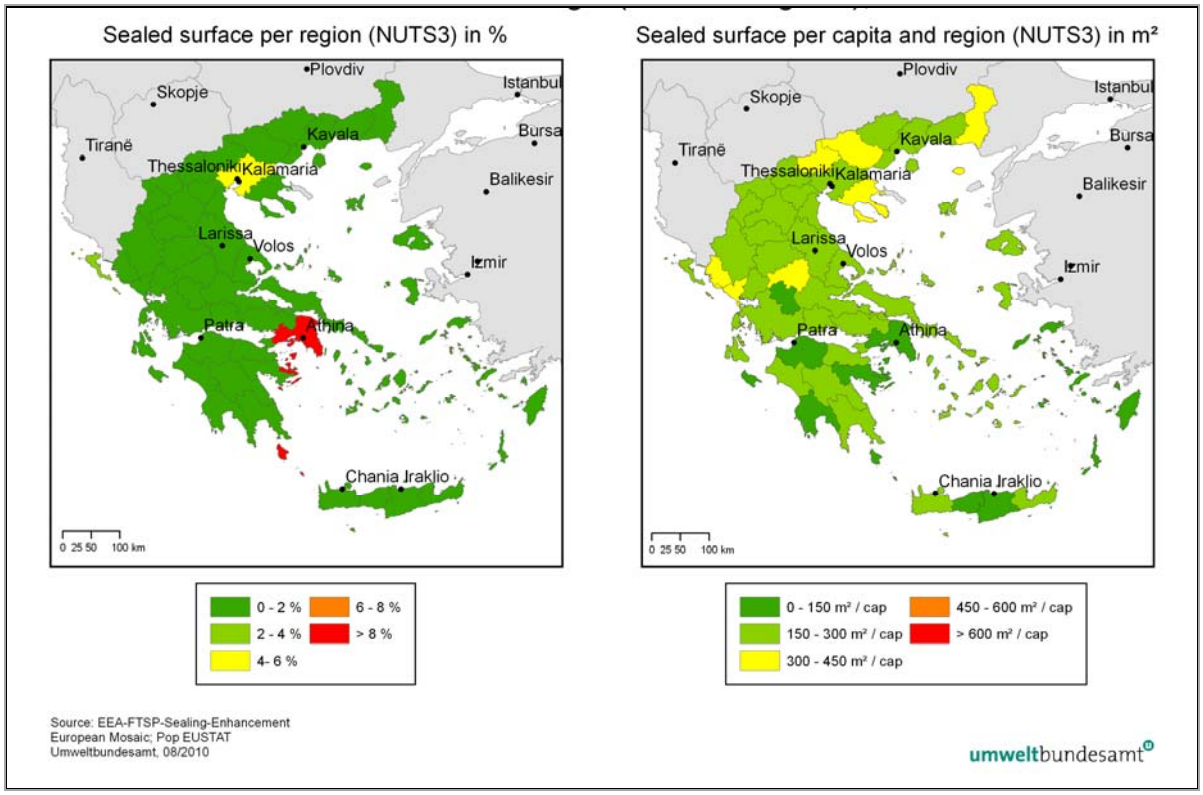


Fig. 38 Greece: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Land take and sealing. Land Cover data are only available for the years 1990 and 2000. The official assessment of EEA on land use changes between 1990 and 2000 refers to a relatively high annual land take of about 3,600 hectares per year, corresponding to 3 m² per capita and year. Unlike other countries key sources of land take were dump sites, quarries, and mines. However, the share of artificial surfaces amounted to only 2.1 % in the year 2000, corresponding to less than 50 % of the EU average. Land use intensity is very high in Greece with on average only 248 m^2 of artificial surfaces per capita. Reasons for this trend are the dense settlement structures of the country. The share of urban population is above 60 % and

41 % of Greece's inhabitants live in cities with more than 100,000 inhabitants.

In 2006 about 1.3 % of the total territory was actually sealed, which is very moderate compared to other EU Member States. Regions under high land use pressure are definitely the Athens agglomeration and selected coastal areas, which are subject to intense touristic infrastructure.

It was not possible to obtain any further information on measures to reduce soil sealing or land take.

2.13 Hungary (short country profile)

Geography. Hungary covers an area of 93,030 km^2 Most of the country has an elevation of fewer than 200 meters. Slightly more than one half of Hungary's landscape consists of flat to rolling plains of the Pannonian Basin. Although Hungary has several moderately high ranges of mountains, those reaching heights of 300 meters or more cover less than 2 % of the country. The highest point in the country is Kékes (1,014 m) in the Mátra Mountains northeast of Budapest. The lowest spot is 77.6 meters above sea level, located in the south of Hungary, near Szeged.

One of Hungary's most important natural resources is arable land. It covers half of the territory, which is outstanding in the world. 19 % of the country is covered by forests. These are mainly mountainous areas.

Demography. Like in most new EU Member States the population has been slightly decreasing in recent years, amounting to minus 1.4 % between 2000 and 2006. Twenty percent of the entire population live in Budapest, the capital, while the next largest city has a population almost ten times less. With 10 million inhabitants Hungary has a population density of 108 people/km$^{2.}$ However the centre of the country, Budapest and its surroundings are much more densely populated than the national average. Hungary is one of the most capital-centred countries in the world. Budapest, located in the northern centre, is the hub of all main roads and railway lines, which run radially toward the capital. This central area also has the strongest economy.

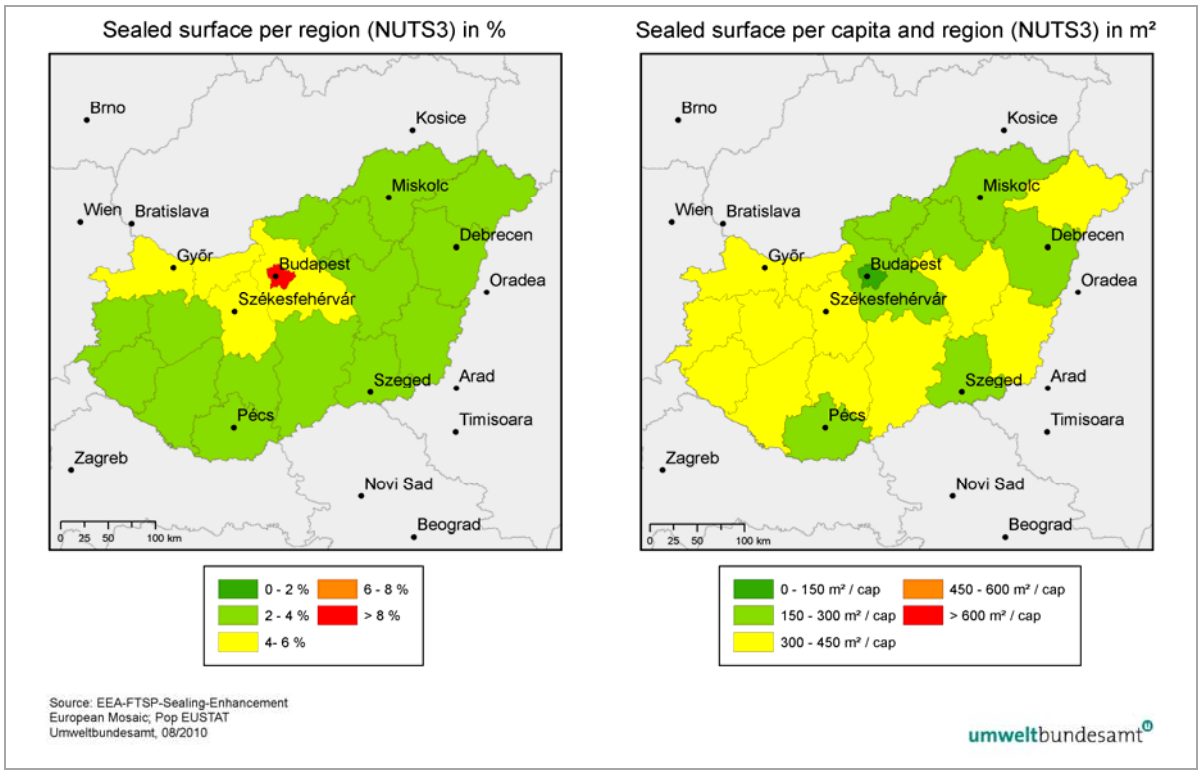


Fig. 39 Hungary: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Land take and sealing. The shares for sealed soil and artificial surface are relatively high compared to the EU average, with 3.2 % and 6 % respectively (EU average is 2.3 % and

4.4 %). However, average rates for land take are rather moderate with on average less than 2 m² per capita and year between 1990 and 2006. The most affected areas are greater Budapest and the region between Budapest and the Austrian boarder.

It was not possible to obtain any further information on measures to reduce soil sealing or land take. A recent expert position from the Ministry of the Environment states *"Sealing is not a well and widely known threat in Hungary, as there is no assessment on its effect on the environment. However, after independence an extensive privatisation process started and the number of investments on greenfield sites increased considerably."*

2.14 Ireland

Geography. With a total area of 84,421 km² Ireland is the 20th biggest island in the world. Its features include low central plains surrounded by a ring of coastal mountains. The island is bisected by the River Shannon, which at 386 km with a 113 km estuary is the longest river in Ireland. The predominant land use in Ireland is for pasture (55.1 %) with arable land making up a further 7.2 %. Wetlands and water make up approximately 24 % of the total area and less than 2 % is covered by cities, towns, houses and roads.

Demography. Ireland has a population of about 4.4 million inhabitants. The country has in total only 9 large cities with more than 50,000 inhabitants. With 506,211 inhabitants Dublin is the largest city followed by Cork with some 119,418 inhabitants. From the 1990ties onwards Ireland became an attractive destination for immigrants from a number of nations, mainly from Central Europe, but also from Africa, Asia and elsewhere. In 2008, Ireland had the largest population growth rate (4.4%) in the European Union. The nation's population is the youngest in the European Union.

2.14.1 Land take and sealing

During the ten years from 1990 to 2000, artificial surfaces increased in area from 1.5% to 1.9% of total land cover, caused by urban sprawl and developments in infrastructure and sports facilities. The six years between 2000 and 2006 experienced a 0.3% increase in artificial surfaces. A growth in forestry from 12% to 12.6% was witnessed during the same period.

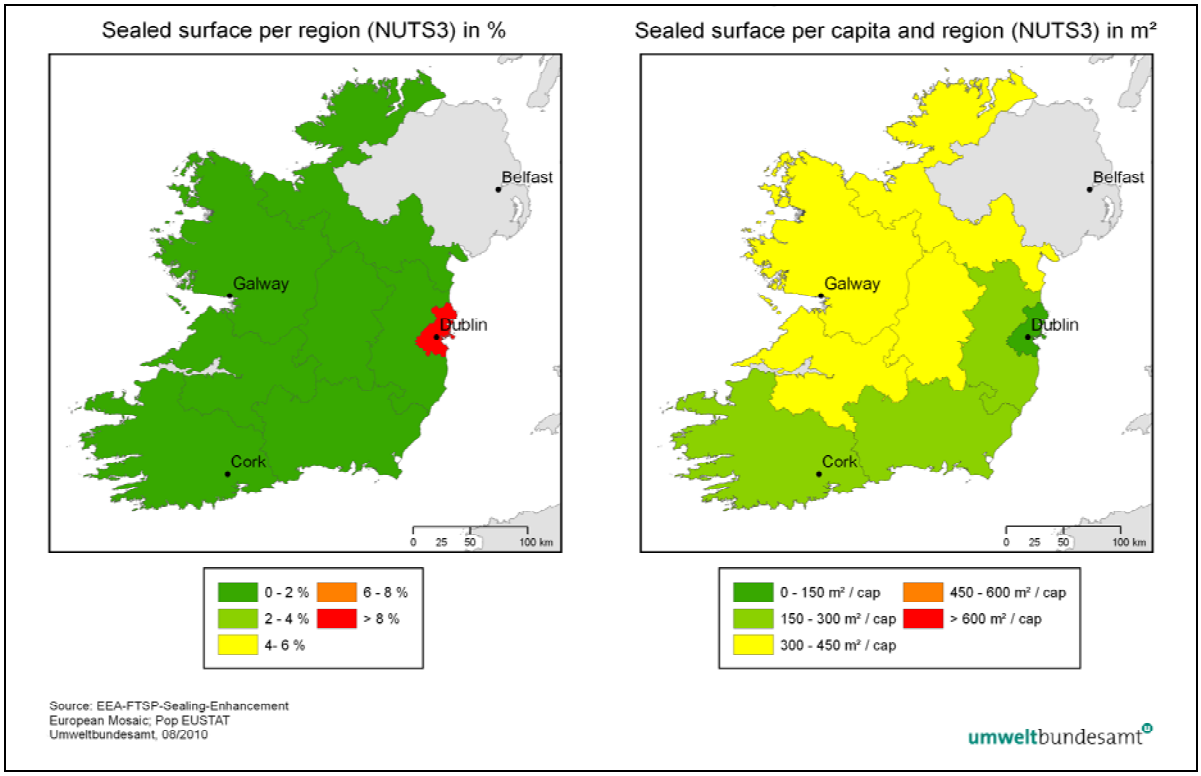


Fig. 40 Ireland: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Ireland has been characterized by high levels of urban growth in the past decade due to a

boom in property prices, associated with economic growth, leading to massive expansion in house building and associated infrastructure. This was characterised by low density and dispersed development in the form of growth on the edge of existing urban areas. As a consequence of this rapid development soil sealing is viewed as an exponentially growing problem, particularly on the outskirts of existing towns with the building of expansive swathes of housing estates [56]. It should, however, be noted that in the past two years (since 2008) this growth has ground to a halt due to the recession/credit crunch.

Comparison with other EU Member States. According to recent CORINE Land Cover assessments the areas of artificial surfaces in Ireland increased by 14 % between 2000 and 2006 at the expense of pasture land, non-irrigated arable land, agriculture land, and green urban areas. On the other hand population growth was also very high with 11 %. The index of artificial surface per capita corresponds to the EU average with 386 m² per inhabitant. In 2006 the sealed surface per capita amounted to 292 m² per inhabitant, which is about 30 % above the EU average. The high sealing rate can be explained with the extremely dense road network for a very sparsely populated country. There are 23 km of road per 1,000 inhabitants; which is one of the highest rates in the whole of the EU [57].

Apart from the CORINE Land Cover data sets no data from Irish authorities with regard to soil sealing or land take are available.

2.14.2 Policies of interest

Ireland appears to have no policies directly focused on the prevention of soil sealing, although the expansion of urban development and its consequences are acknowledged as a growing problem, with the latter prioritised within planning policies. The only evidence of action targeted specifically at soil sealing is the development of the EPA's Soil Research Platform and the prioritisation of sealing within their efforts. The desire to minimize the consumption of soils is briefly referenced within the National Spatial Strategy, but this is only in the context of a large list of other priorities. Therefore policies in Ireland primarily address soil sealing indirectly as a consequence of ambitions to reduce urban sprawl and associated policy measures.

In the assessment of Irelands Environment 2008, the chapter dedicated to soil issues noted that 'there is no comprehensive information on the quantity and quality of soil being lost to surface sealing in Ireland on an annual basis or the consequences of this in terms of loss of soil functionality and increased flooding risks' [58].

Spatial Planning. The National Spatial Strategy [59] sets out a twenty year planning framework for Ireland between 2002 and 2022. It is a strategic policy document stating the spatial objectives for the coming two decades, the adoption of which was driven by a recognition that unbalanced development in Ireland was affecting the quality of life. The document sets a framework designed to deliver more balanced social, economic and physical development between regions. The need for the national Spatial Strategy was, however, driven by primarily social factors i.e. concerns over the distance of commutes, isolation of developments etc; although the environmental impacts of sprawling developments is acknowledged. The document highlights sustainable development and minimising the consumption of soil, there is a reference to the reduction of urban sprawl by enforcing inner urban development and the protection of green belts around towns.

Legal Planning Requirements - The Planning and Development Act, 2000, together with the Planning and Development Regulations, 2001, the Planning and Development Regulations, 2002 and the Planning and Development (Amendment) Act, 2002 form the basis of planning

law in Ireland. The National Strategy is converted to the regional level through provision of guidance setting out the content and approach for example to be adopted to development planning. Regional Planning Guidelines no 15 on Development Plans [60] does not explicitly mention reduction of soil sealing as an objective, indirectly effective zoning and promotion of brown field development are mentioned as priorities.

Each County sets out a Development Plan allocating areas for development, this is then translated into local plans. These plans (based on the regional Planning Guidelines) are instrumental in defining areas for development and protection. Importantly, due to the recession the areas for development have been dramatically reduced in recent months.

For example the Waterford County Draft Development Plan, which went on display in February 2010 proposed a major rezoning of development with 70-90 % of land allocated for development reassigned. As a consequence development land is reallocated as agricultural land, given the dramatic drop-off in house prices and the need for new housing. While the new Waterford County Development plan remains under development (in Ireland development planning periods now run from 2005 to 2011), the (operational) current plan contains requirements to protect water, natural habitats etc there is no mention of the need to consider soil function or quality in development decision making. The strategy highlights the need to develop brownfield land as a priority but primarily for issues associated with societal structure and infrastructure rather than the protection of quality land. In one indirect nod to the need to address sealing, in terms of the flood risk associated with new development the plan states that: *'proposals for housing estate development or for the development of a large number of houses in a particular area, shall be required to submit a Flood Impact Assessment and proposals for a Sustainable Urban Drainage System (SUDS) – this is a sequence of management and control structures designed to drain surface water in a more sustainable manner than conventional techniques, and is also applicable to rural areas'.*

Flood Risk. In response to the review group's findings, in December 2009 the Department for environment, heritage and local government published a set of guidelines for local authorities on dealing with flooding within the planning system in Ireland [61]. The Irish planning authorities are obliged to take account of the guidance. The document focuses primarily on mechanisms to avoid in appropriate development in areas at risk of flooding. However, the question of poor infiltration impacting on flood risk is again raised. In response to this the guidance included a section dedicated to Sustainable Drainage Systems (SuDS). It notes that the development of previously 'green' or permeable land increases the impermeable area in urban areas and that drainage systems, while limiting local flooding, mean that runoff reaches surface waters quickly increasing the flood risk associated with water courses. It is noted that the Department is reviewing their guidance 'Recommendations for Site development Works for Housing Areas', which sets out design standards from drainage systems. The intention is to include within this review a set of best practices regarding SuDS (this is yet to be published).

The floods and planning guidance specifically recommends the adoption of permeable pavement techniques including the use of porous tarmac or solid block pavers with gaps to provide through flow of water. It also specifically references the increasing trend for paving over residential garden areas and that a review of rules regarding the conversion of gardens to hard standing from planning requirements will be reviewed to ensure compliance with SuSD principles. As an interim measure the guidance specifies that planning applications for new or extensions to residential development should seek to reduce the extent of hard surfacing and if not require the use of SuSD approaches including in particular permeable paving or surfaces such as gravel or slate chippings.

Reuse of brownfield land. While the Irish EPA have developed guidance on the development of brownfield sites, highlighting the benefits for urban renewal and approach to treating sites [62] efforts to specifically promote brownfield development is focused with the prioritization in development plans. The desire to use in-fill as a preference to Greenfield sites is highlighted in the National Spatial Strategy, with the need to priorities brownfield sites set out in Planning Policy Guidance 15 on Development Plans. Evidence of this requirement seeping into development plans is provided by the references within the Waterford County Development Plan.

Protection of agricultural soils. None could be identified at this stage, although the reference to 'Green Structure' development around urban areas in the National Spatial Strategy suggestions that this is an issue of increased interest. No policy explicitly protecting agricultural land from development based on soil characteristics could be identified. Additionally, it is noted in various dossiers including the review of soil issues within the 2008 review of the Irish Environment that there are significant gaps in knowledge regarding the quality of soils in Ireland.

2.14.3 Conclusions

While soil sealing has been a significant issue for Ireland in the past years of the housing boom, the recession appears to have reduced dramatically the need to expand development in Ireland. As a consequence changing socio economic factors have in some ways alleviated the pressures.

Despite the past potential concern over soil sealing no policies could be identified as explicitly dealing with this. The only evidence of action directly associated with sealing is the inclusion in the priorities for the Irish EPA's Soil Research Platform and the inclusion of sealing as an issue on the Soil Science Society of Ireland's Nov 2009 event focusing on soil challenges in Ireland.

In terms of efforts that might indirectly support soil protection, there appears to be efforts specifically underway to promote sustainable urban drainage systems and limit urban sprawl. There is also limited to wording promoting brownfield development and the responsible zoning of development. There are as yet no specific targets relating to this but a requirement for planning authorities to address these issues in development plans.

The only mention of technological solutions that could be identified was the need to construct new housing estates with reference to guidance on Sustainable Urban Drainage or SUDs, specifically supporting the use of permeable pavements. There are also moves to limit the creation of hard standing in gardens including limiting use of hard standing in new/extended dwellings.

2.15 Italy

Geography. Italy is a mountainous country, with the Alps as the northern boundary and the Apennine Mountains forming the backbone of the peninsula. The large plain in the valley of the river Po and the coastal regions are among the most densely populated regions in Europe.

Demography. Italy's population exceeded 60 mio. inhabitants in 2010. After the turn of the century population growth was significantly above the EU average mainly due to immigration. The population density, at over 200 persons per square kilometer, is the fifth highest in the European Union. The highest density is in Northern Italy, as that one-third of the country contains almost half of the total population. The largest cities are Rome (2.7 million inhabitants) and Milan (1.3 million inhabitants). About one third of the population lives in cities with more than 50,000 inhabitants. Total urban population exceeds 60 %.

2.15.1 Land take and sealing

Comparison with other EU Member States. The share of artificial surfaces amounts to 5 % and the share of sealed surfaces to 2.8 %, both of which are slightly above the EU average.

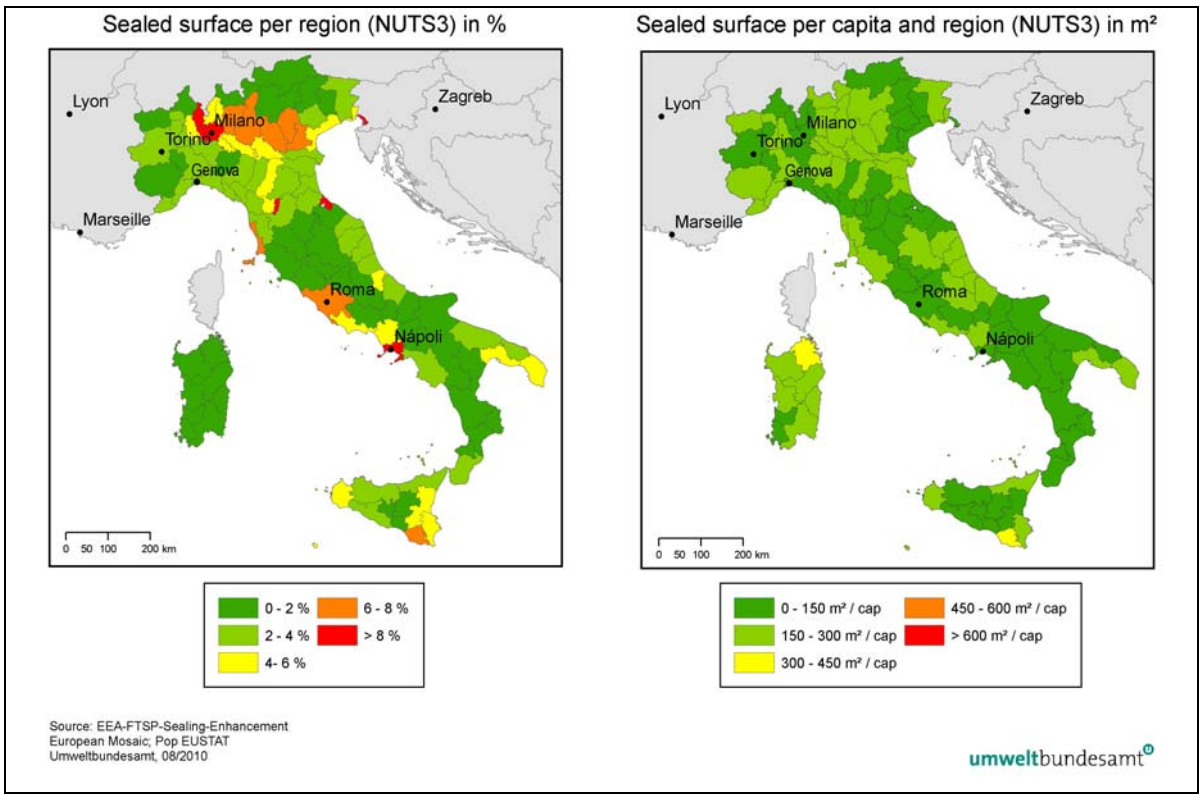


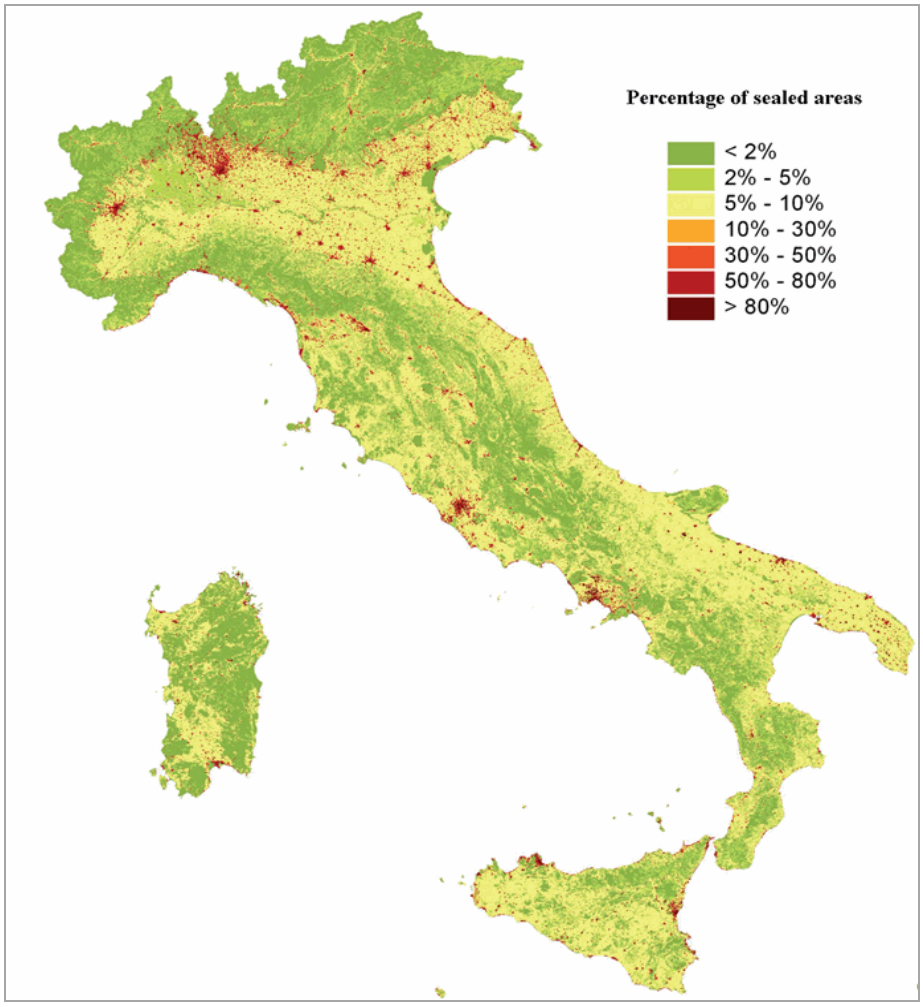
Fig. 41 Italy: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Both the average index for artificial surface and sealed area per capita are among the lowest

in European Union, with 255 and 144 m^2 respectively.[50] . As already mentioned in the introduction (see also Fig. 5) land use intensities highly depend on dominant settlement structures. Italy has a high share of urban population exceeding 60 % and a high density of large cities, namely 50 cities exceeding 100,000 inhabitants and about 100 cities with 50,000 to 100,000 inhabitants.

Urban sprawl and soil sealing are reduced to several hot spot areas, which are the so-called industrial triangle formed by Milan, Turin and Genoa, the basin of the river Po in the North, and the coastal regions.

Between 1960 and 2000 artificial surface increased by 300 %; in the same period population growth was observed to be rather moderate with only 3.6 %. Fastest growth rates were observed in the coastal regions and the Po River plain. After 2000 a stagnation of the growth rate of artificial surface can be observed. In the period 2000 to 2006 population and artificial surface have the same growth rate of +3.5 %. In comparison with other EU Member States Italy has a very low index of artificial surface per capita with only about 255 m² per capita. No increase of this index was observed between 2000 and 2006 [63].



50 Sealing per capita in 2006: 155 m² according to EEA Soil Sealing Data Base,
Artificial Surface per capita in 2006: 255 m² according to CORINE land Cover Classification

Fig. 42 Italy: National soil sealing map
Source: ISPRA [64]

The national map of sealed areas due to urbanization (Fig. 17), is based on data from CORINE Land Cover 2000, and shows that the highest sealing rates are found in Lombardy, Apulia, Veneto and Campania with higher concentrations near urban areas and along the main road axes. Key land se problems occur in particular in the large plains, where urbanization is coupled with intensive farming.

2.15.2 Policies of interest

Spatial Planning. Unlike most European countries Italy does not have a higher level spatial plan, such as a national spatial development plan, that would influence or govern the regional plans for a defined period. Plans at the national scale are limited to highways, railroads, and similar structures. The 20 Italian regions have a high degree of autonomy with regard to spatial planning, and the most important planning document is the Regional Territorial Plan (PTR). The planning hierarchy is as follows:

- regional territorial plans (Piano Territoriale Regionale),
- provincial territorial coordination plans (Piano Territoriale di Coordinamento Provinciale) and metropolitan area plans (Piano Regolatore Generale Intercomunale),
- municipal master plans (Piano Regolatore Generale Comunale - PRGC), and
- district plans (PP).

The regional territorial plan covers regulations on particular land use, land development at a larger scale, and the planning of infrastructure such as road network and railways. The regional territorial plan is jointly drafted by representatives of the provinces, municipalities, private entities, and other stakeholders and is finalized by obtaining the approval of the regional assembly [65].

Soil sealing limits at the municipality level. At the municipality level, city plans regulate urban transformation and can actually restrict soil sealing and lead to a balance between urban development and environmental protection. Sealing limits apply to new developments (building activities) and are currently used in several municipal master plans, among them Milano, Brescia, Padova, Parma, Modena, Bologna, Firenze, Roma; and all municipalities of the Alto Adige region. However, the sealing limits are quite varied, both with regard to methodology and definition of “sealed area”. In the following a few examples are described [66]:

- Brescia. The Piano Regolatore Generale Comunale of Brescia fixes some minimum values for the extension of permeable green areas, ranging from 15% in town centre to 35% in residential areas. The index used is linked to definitions of “permeable area” (rain water absorption >70 %), “semi permeable area” (rain water absorption 70 %-50 %) and “sealed areas” (rain water absorption <50 %).
- Padua prescribes “surface permeability” according to land use classes; i.e. 30 – 40 % permeability in residential areas, 70 % for parking areas, and 90 % for green public areas.
- Parma. Minimal standards for “surface permeability” are 75 % for private gardens and 15 – 50 % for commercial areas.
- Rome. Apart from sealing limits for new building activities, the city planning puts special emphasis on inner urban development.

- Municipalities in Alto Adige. The limitation of soil sealing is prescribed in the municipal zoning which refers to site specific *Sealing Indices*[51] (see also chapter on mitigation measures).

Environmental Quality in Urban Areas. Some Italian regions have enforced regional laws on environmental quality in urban areas, as this is the case in Emilia Romagna, Toscana and Umbria. (1) In Emilia Romagna[52] the *Regional Law on Urban Soil Protection* explicitly demands soil sealing restrictions in urban areas. The city planning has to consider soil sealing as standard environmental parameter in city planning. (2) In the region Tuscany[53] environmental quality, building quality and accessibility have priority and soil sealing has to be contained as far as possible. These requirements are subject to a quantity and quality evaluation. (3) Umbria[54] supports sustainable building techniques by supporting training programmes and providing special incentives. Overall objective is to reduce the consumption of natural resources and to improve the quality and comfort of the urban environment.

2.15.3 Best practice

Research. In 2009 a national research project was launched with the title research *Centre on Soil Consumption*[55], and will operate from 2009 to 2011. The National Centre for Urban Affairs (Istituto Nazionale di Urbanistica) is the key supporter of the project. Key action lines are (1) the technical aspects of monitoring soil sealing, (2) the development of specific planning tools to support efficient land use to be implemented at the local level in the region Lombardia, and (3) the stipulation of the public debate on soil consumption and resulting negative effects.

2.15.4 Conclusions

Northern and coastal regions in Italy are highly affected by soil sealing and urban sprawl. Since 2000, a stagnation of soil sealing rates can be observed. In comparison with other EU Member States Italy's land use efficiency is outstanding with only 155 m² sealed surface per capita and 255 m² artificial surface per capita.

Measures to reduce soil sealing exist in several Italian municipalities at the city planning level. Research and awareness towards soil sealing, urban sprawl and their negative impacts are growing.

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51 B.V.F. - Verfahren (Beschränkungsindex der versiegelten Flächen)
52 art. A-25 , Legge regionale 24 marzo 2000, n. 20 "Disciplina generale sulla tutela e l'uso del territorio.
53 Art. 37, Legge regionale 3 gennaio 2005, n. 1 "Norme per il governo del territorio"
54 Art. 43, Legge regionale 1/2004 "Regolamentazione dell'attività edilizia"
55 Centro di Ricerca sui Consumi del Suolo, http://www.inu.it/attivita_inu/CRCS.html

2.16 Latvia (short country profile)

Geography. Latvia has many similarities to Estonia; the country is also small and sparsely populated, with on average 34.6 inhabitants per km². Half of the Latvian population is living in the area of the capital Riga.

Demography. Like in most new Member States declining population trends can be observed. Between 1990 and 2000 out-migration is most significant with a population loss of 11 %. After 2000 Latvia is recovering from this process and the number of inhabitants remains almost stable.

Land take and sealing. The shares for sealed soil and artificial surface are relatively low compared to the EU average, with 1.1 % and 1.3 % respectively (EU average is 2.3 % and 4.4 %).

Major urban areas were developed on less productive sandy soil in the northern part of the country while agricultural productive land is situated in the less populated South of the country.

Fifty percent of the Latvian agricultural land is fallow land. Since independency and liberation of the economic system the production on less productive land is in many cases not profitable. Another reason is the transfer of agricultural land to original owners, who do not use the land and cannot sell it because of the low prices.

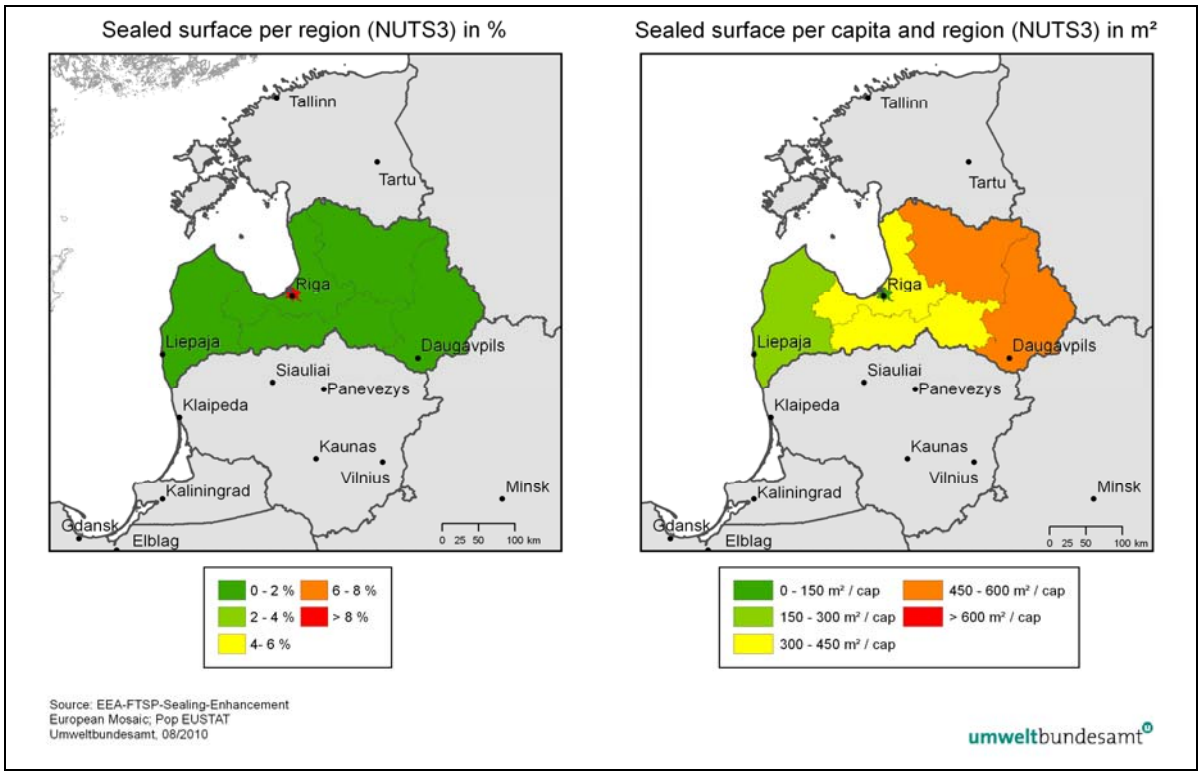

Fig. 43 Latvia: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Policies of interest. Latvia is currently establishing a policy regime for sustainable spatial planning. Key milestones of this policy regime are the *Land Policy Guidelines for 2008-2014*[56] which have recently been published. Their major objective is to ensure sustainable land use and land protection, including protection of entrails of the earth, forests, waters, and to prevent land degradation. An important follow-up policy document is the Land Management Conception, which is currently being developed. As soon as the document will be approved, the key principles will be transposed in legal acts. The Land Management Conception covers subjects such as land use principles, the rights and responsibilities of land users, competence of the state and local municipalities in land management, landscape protection, planning and management, measures to prevent land degradation etc. Specific land use pressures of concern are:

- **Urban satellites**. In the past years, a significant number of small residential areas consisting of only a few houses (garden flats or low apartment houses) were developed a few kilometres outside of existing urban areas on the green field. These developments were carried out by private developers. Thus urban areas could have many of these "satellites" leaving gaps of green spots in between them. It is under consideration to include a regulation in the new land use management a regulation that obliges urban administrations to fill these gaps before allowing the development of new residential areas on a green field.
- **Coastal areas**. Another issue for discussion are housing permits in non-developed coastal areas in order to attract more people to live there and generate tax income for the towns concerned.

[56] 2. The Land Policy Guidelines 2008-2014, available in Latvian at http://polsis.mk.gov.lv/view.do?id=2812

2.17 Lithuania (short country profile)

Geography. Of the three Baltic counties Lithuania is the largest and most densely populated, with on average 51 persons per km² - still much below the EU average. The Lithuanian landscape is predominantly flat, with a few low hills in the western uplands and eastern highlands. The highest point is only at 294 metres (Aukštasis). Lithuania is also rich in water bodies, with 758 rivers, more than 2,800 lakes and 99 km shore line along the Baltic Sea coastline. Forests cover just about 30% of the territory and 60 % are agricultural land. Major cities are the capital Vilnius, with about half a million, Kaunas with 480,000 and Klaipedra with approximately 200,000 inhabitants.

Demography. In 1990 Lithuania's population amounted to 3.7 million and has been decreasing since. In particular young and well educated people leave the country to work abroad. Other reasons are the low birth rate with only 1.3 children per woman and the relatively high infant mortality rate with 14. 7 deaths per 1,000 live births.

Land take and sealing. The shares of sealed soil and artificial surface are relatively low compared to the EU average, with 2 % and 3.3 % respectively (EU average is 2.3 % and 4.4 %). Average rates for annual land take are also very moderate with on average less than 1.5 m² per capita and year between 1990 and 2006.

It was not possible to obtain any further information on measures to reduce soil sealing or land take.

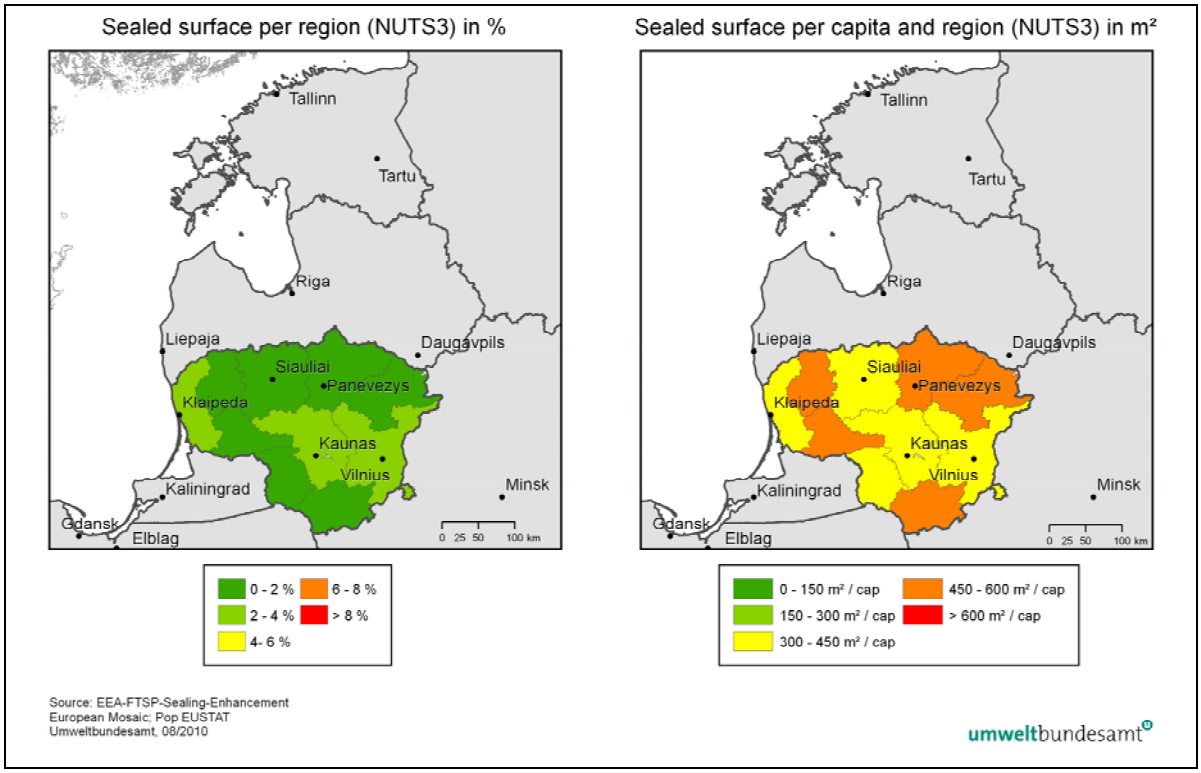

Fig. 44 Lithuania: Soil sealing per region in 2006
Source: EEA, EUROSTAT

2.18 Luxembourg

Geography. Luxembourg covers an area of 2,586 km². The northern section of the country is formed by part of the plateau of the Ardennes, where the mountain heights range from 460 to 559 m. The highest altitude of the country is the Buurgplaatz with 559 meters. The rest of the country is made up of undulating countryside with broad valleys. The lowest level of the land is claimed by the river Moselle which goes down to 133 meter below the sea. 24 % of the country is covered by arable land, 1 % by permanent crops, 20 % by permanent pastures and 21 % by forests and woodland. 34 % are other uses.

Demography. Of the country's 502 066 inhabitants about 28 % live in Luxembourg-city and its immediate surroundings. Luxembourg's population increased by 8 % between 2000 and 2006, making the country one of the fastest growing Member States after Malta, Spain and Ireland. The number of foreign residents in the Grand Duchy has already exceeded 43% of the population. It is the highest proportion of foreigners of any EU country. Luxembourg belongs to the fastest growing country

2.18.1 Land Take and sealing

With an area of 2,586 km^2 Luxembourg is, after Malta, the second smallest country of the European Union. About 92 % of the inhabitants live in cities which are mainly small, rural towns. The largest town is the capital Luxembourg with about 86,329 inhabitants. Due to economical growth the country had, in the last decades, an almost continuous growth in population and was highly affected by urban sprawl.

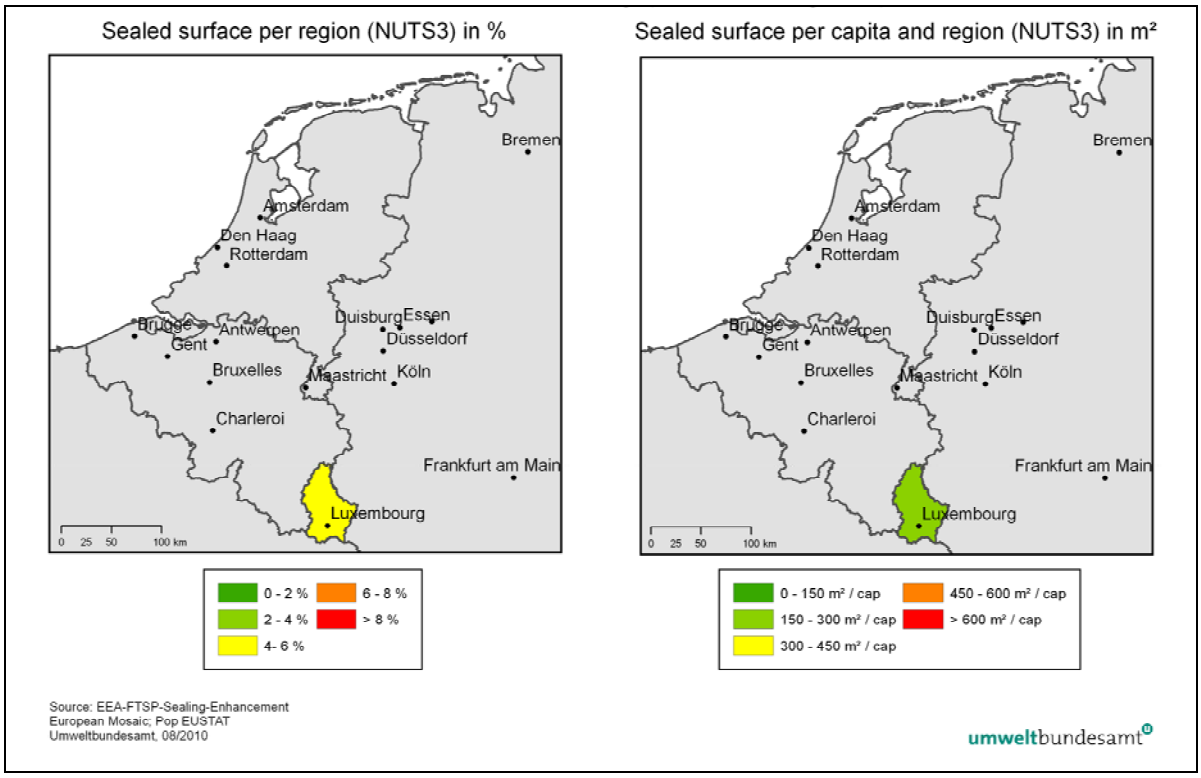

Fig. 45 Luxembourg: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Since 1972 the amount of built-up area almost tripled, whereas population increased by only 38 % (see Fig. 14 on page 51). Direct causes are the fact that people live in the countryside

and work in the city, the demand for larger dwellings (68% of households live in houses) and the rapid growth of the of the road network. Over the past 30 years the car ownership increased by 230 %, making it one of the densest in the world. This profound transformation in the lifestyle of Luxembourg's society has led to an unprecedented consumption of space over the last quarter of a century. The primary consequence of this wave of urbanisation is a continuous and irreversible reduction in rural areas and a decline in rural environment per se.

Comparison with other EU Member States. Luxembourg is heavily affected by landscape fragmentation, urban sprawl and soil sealing. In 2006 the share of artificial surfaces was at 9.3 % and at 4.9 % for sealed surfaces - both values correspond to about the double of the EU average.

Awareness towards rapidly increasing urban sprawl started in the end of the 1990ies. Several legal measures were successfully implemented and a trend reversal is already visible. The amount of artificial surface per capita is about one third higher than the EU average. However, in the period 2000 to 2006 population growth was observed to be higher than the increase in artificial areas, and land use on already existing built-up area could be intensified; the amount of artificial surface per capita decreased from 554 m² per inhabitant to 515 m². the amount of sealed surface per capita is at 263 m² per inhabitant and about 16 % higher than the EU average.

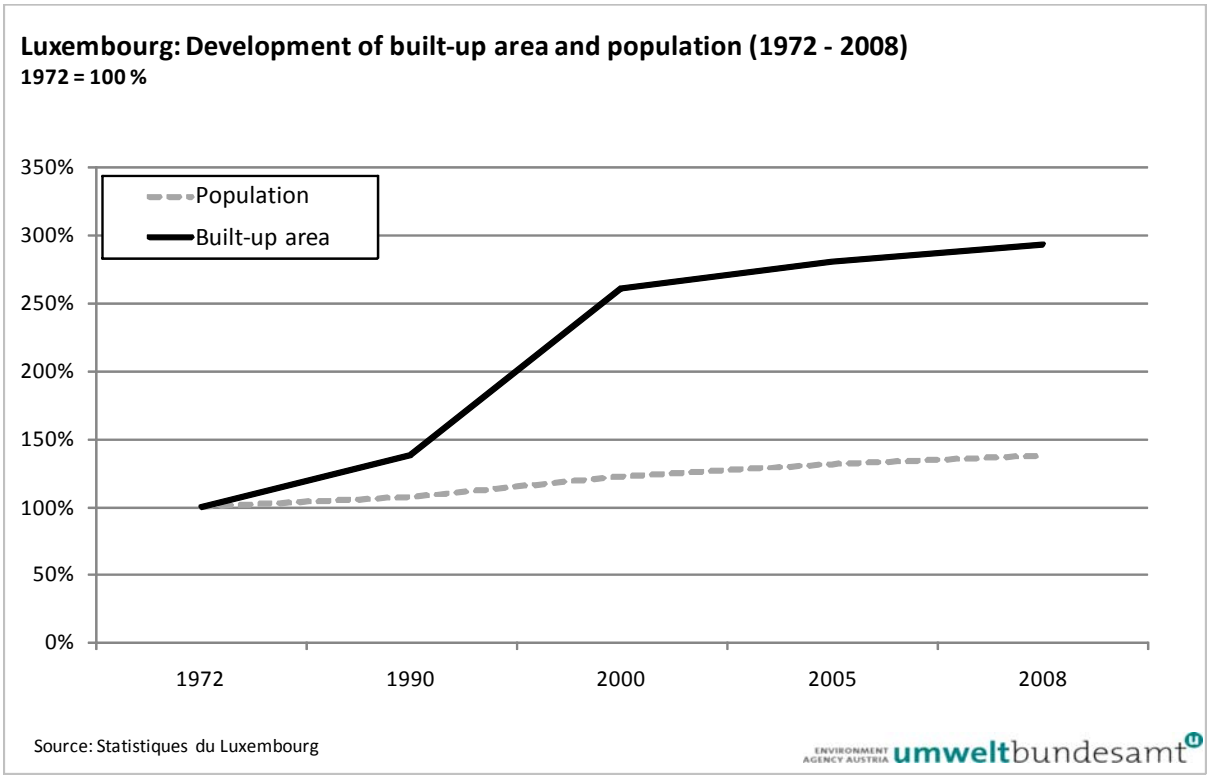

Fig. 46 Luxembourg: Development of built-up land and population
Source: Le Portail des Statistiques du Luxembourg

2.18.2 Policies of interest

The disproportional development of population and built-up area was clearly perceived as an unsustainable trend. At the turn of the century the government initiated legal measures to reach a trend reversal.

Policy Target. In 2009 the National Plan for Sustainable Development claims a stabilisation of future land take to a maximum of 1 hectare per day until 2020. The Plan recommends the introduction of a sealing tax, the enhancement of already initiated planning measures, and to pass a specific law on soil protection [67].

Spatial Planning. Spatial planning is governed by the National Spatial Planning Programme[57], which is not legally binding and which prescribes planning principles for a defined period. The last revision was published in 2003 and specified the reduction of urban sprawl and land take as key objective for the future. The programme is administrated at two levels, namely the national and the local level, and is based on three major laws (see below). On the national planning level the role of the Government is predominant in economic development, rural planning, major public works, infrastructure projects and environmental protection. The municipalities play an important role in the fields of local development, town planning and urban regeneration. The spatial planning system in Luxembourg is based on three major laws.

- The *Act on Spatial Planning* (1999) introduces the concept of sustainable development as the basic orientation of spatial planning and it seeks to improve horizontal coordination on the national level and vertical coordination between the Government and the municipalities. The law puts emphasises on efficient use of soil, the protection of landscapes, a balanced development of urban and rural structures
- The *Act on the development of cities and other significant agglomerations* (2004) regulates the planning at the municipality level and needs approval by the Ministry.
- The *Act on the Protection of the Environment and the Natural Resources* (2004) is under the responsibility of the Minister of the Environment and regulates the balanced management green areas (see below → Protection of Green Areas)
- The disproportional development of population and built-up area was clearly perceived as an unsustainable trend. At the turn of the century the government initiated legal measures to reach a trend reversal.

Reducing Urban Sprawl. In order to make the principles of the National Spatial Planning Programme operational the so called IVL, the *Integrated Transport and Spatial Development Concept for Luxembourg* was elaborated under consultation of all relevant stakeholders. Key objective of the IVL is that 25 % of private transport shall be covered by public transport until 2020. The IVL is based on the principle that a certain critical mass of urban density is needed to allow affordable public transport and the reduction of green house gases from private transport. In Luxembourg such a critical mass of urban density was in general missing and needed to be intensified. To reach this goal consequent inner urban development and reuse of brownfields and underused land. Key claims are (1) the definition of specific minimum urban densities and the implementation of a binding index for local land use plans, (2) the establishment of a land management system to identify development potentials and a data base for “fill-in” areas, (3) the introduction of binding development obligations for land with a building permit or otherwise the withdrawal of building permits without refunding, and (4) to institutionalise public land management agencies at the municipality level [68].

Assessment of Spatial Planning Principles. Four years after its publication the IVL was evaluated by means of 29 sustainability indicators, many of which directly address soil consumption, but also refer to other topics, in particular the densification of urban areas, land

[57] Programme Directeur d'Aménagement du Territoire

use efficiency, and improvement of urban transport. The assessment clearly outlines strength and weaknesses of recent spatial developments, in particular the failure to increase building densities in rural areas [69].

Protection of Green Areas. Polycentric development and urban areas with high living standards are key objectives of Luxembourg's spatial development. For the whole country a map with protected green land was issued. Classified green land is not available for urban development. The process is based on the *Act on the Protection of the Environment and the Natural Resources* and is under the responsibility of the Minister of the Environment.

2.18.3 Conclusions

Up to the turn of the century Luxembourg was severely affected by disproportional urban sprawl and very low urban densities. The reduction of urban sprawl is a priority issue on the political agenda of the country.

Due to the implementation of a comprehensive spatial planning concept a trend reversal could be reached. Awareness towards rapidly increasing urban sprawl started in 2003 with the implementation of sustainable urban planning. Key objectives are inner urban development, increase of urban densities and improvement of the public transport system to reduce the consumption of soil resources and the reduction of green house gases by private transport.

2.19 Malta (short country profile)

Geography. The smallest EU Member State with only 315 km² is an archipelago in the central Mediterranean Sea consisting of 3 main and some few smaller islands. Only the three large islands, Malta, Gozo, and Comino are inhabited. The landscape consists of low hills with terraced fields. The lack of constant rivers or lakes is a challenge for agriculture as well as the inhabitant's water supply. The country is strongly dependent on food imports, has limited freshwater supplies and no domestic energy sources.

Demography. Malta belongs to the fastest growing Member States, with a growth rate of 7 % between 2000 and 2006. This trend is expected to continue. The population density in Malta is the highest within the EU with 1,282 inhabitants per km².

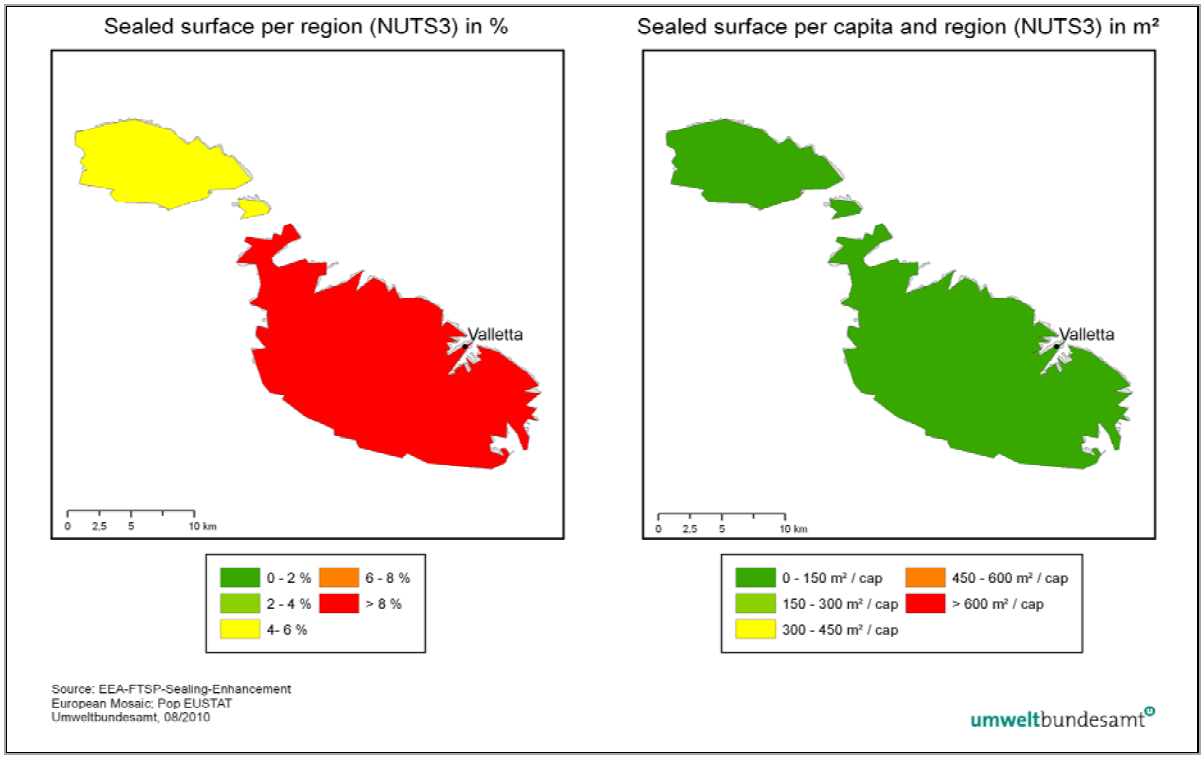

Fig. 47 Malta: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Land take and sealing. Land use pressures in Malta are definitely extreme, since the island's territory is to 26 % artificialised and to 13 % sealed. The island can be considered as one urban agglomeration as the average population density corresponds to the one of a medium sized city. Population growth is also among the highest in Europe. Between 2000 and 2006 land use intensity could be considerably improved. In this period population growth was still high with 6.5 % whereas growth of artificial surface was almost insignificant with 0.1 %. As a result the amount of artificial surface per capita decreased from 215 m² to 202 m² per capita.

According to the Ministry for Development of Infrastructure there is still significant potential for improving the overall efficiency of land use, in view of the over-supply of residential, commercial and industrial premises. In 2005, 22.4 % of residential dwellings were permanently vacant, similar over-provision have also been observed in the commercial sector. It was not possible to obtain any further information on measures to reduce soil sealing or land

take.

2.20 The Netherlands

Geography. The country can be split into the low lands and the higher lands. The low and flat lands are situated in the West and North of the country. These lands, including the reclaimed polders and river deltas, make up about half of its surface area and are less than 1 m above sea level, much of it actually below sea level. The higher lands with minor hills are situated in the East and South. Even this portion is mostly flat, with the Vaalserberg (322.7 metres above sea level) being the highest elevation at the foothills of the Ardennes. 25 % of the country is covered by arable land, 3 % by permanent crops, 25 % by permanent pastures and 8 % by forests and woodland.

Demography. 16,499,084 inhabitants are concentrated on an area of 41,526 km²; this means that the country has a population density of 397 per km². Considering only the land area (33,883 km²) even increases population density to 487 inhabitants per km². *Randstad-Holland* (or simply: "Randstad") is one of Europe's largest urban agglomerations, including the cities Amsterdam, Rotterdam, Den Haag and Utrecht. Randstad Holland covers about 20 % of the Dutch territory, inhabits more than 40 % of the Dutch population, and has an average population density of 937 capita per km².

2.20.1 Land take and sealing

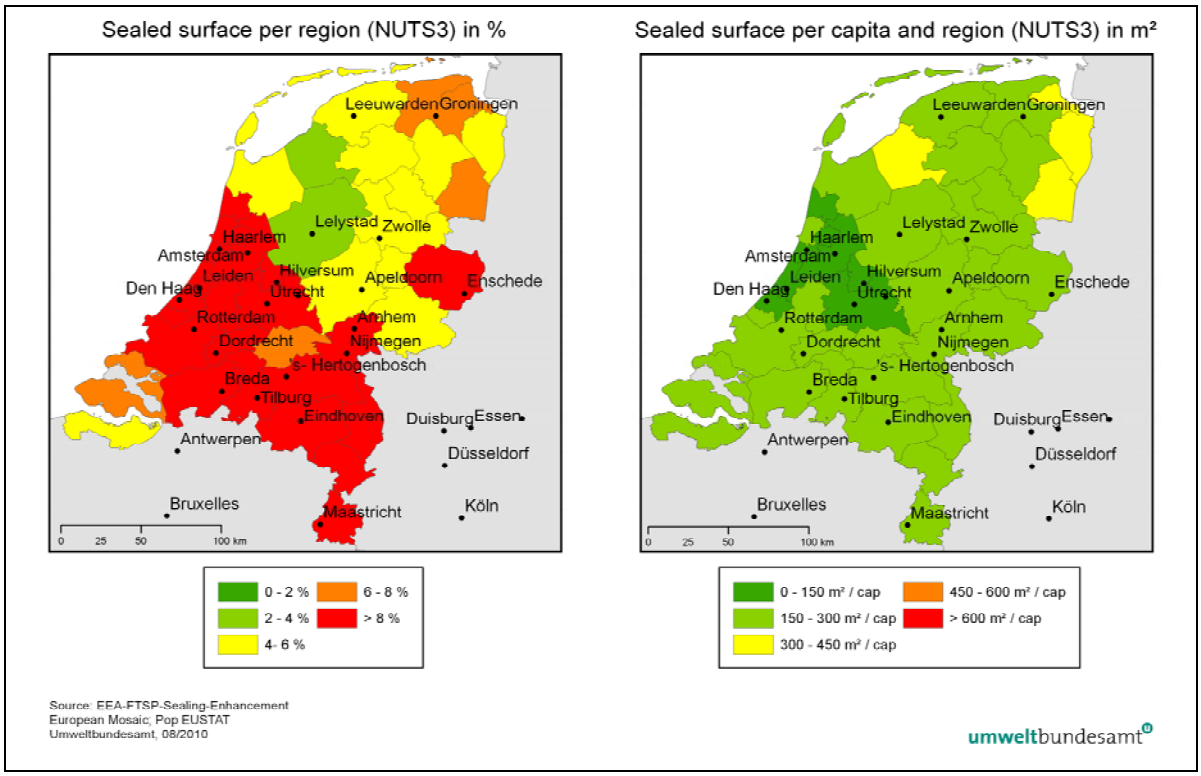

Fig. 48 The Netherlands: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Comparison with other EU Member States. The Netherlands have after Malta the second highest rates for artificial surfaces and sealed surfaces. In 2006 more than 13 % of the Dutch territory were classified as artificial surface and 8 % of the territory were actually sealed. Fast population growth and increasing demand for single family dwellings resulted in enormous

land take in a country with very limited space. However, the amount of annual land take slowed down after the turn of the century, but land use intensity could not be improved. The amount of artificial surfaces per capita increased in the period 1990 – 2006 (see also Fig. 7 and Tab. 2).

In the past decades the Netherlands experienced enormous population growth, which slowed down after the turn of the century. Fastest growth rates can be observed for the period 1964 and 1998, when population increased by 26 %, and built-up areas increased by 65 %[58] (see also Fig. 49) [70]. In recent years population growth and land take slowed down and the outlook for the future predicts even slower growth rates. However, the Dutch population is still growing faster than in most other Member States and has to cope with limited space.

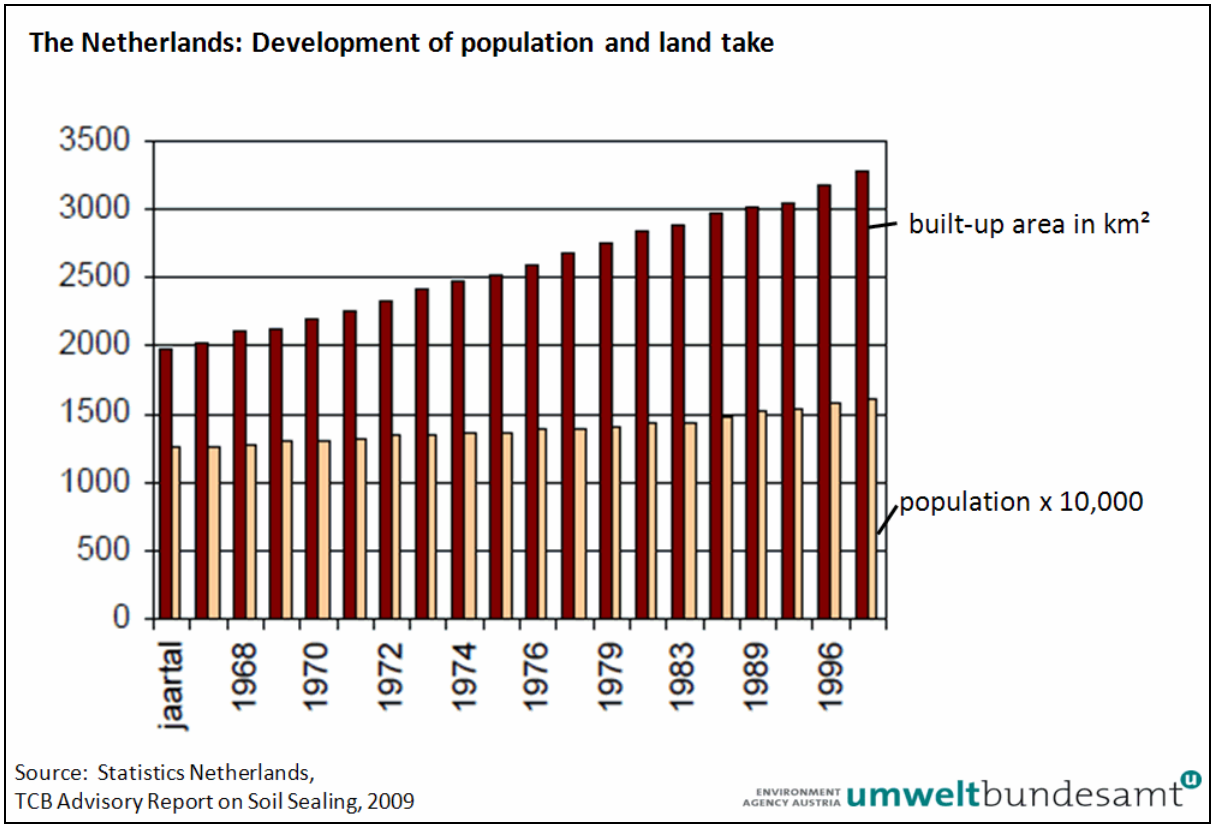

Fig. 49 The Netherlands: Development of population and land take.
Source: Statistics Netherlands

The WLO[59] expert group (Welfare, Prosperity and Quality of the Living Environment) published four different scenarios for the development of the Dutch society until 2040 [71]. In the strongest growth scenario *"Global Economy"* most emphasis is put on international cooperation and private responsibilities, whereas in the most moderate growth scenario *"Regional Communities"* the focus is on national sovereignty and public responsibilities (see also Tab. 4). The outlook concludes that population growth will slow down in all scenarios and in one scenario even turn into a population decrease. Furthermore is the demand for housing, industrial land use, traffic and transport expected to level off after 2020 in two of four scenarios. Key findings with regard to future land use pressures are:

58 Statistics Netherlands; http://statlinecbs.nl
59 Welfare, Prosperity and Quality of the Living Environment

- Housing. The highest demand for housing will continue to be in the highly urbanized Randstad area. In order to avoid the degradation of city quarters the Dutch government should aim for restructuring and housing quality.
- Industrial land use. Restructuring will also become a priority in industrial areas. In most scenarios there will be no further need for additional industrial estates after 2020. A growing service economy will gradually transform many industrial estates into business parks. As a result, environmental risks will decrease, but traffic will grow.
- Traffic and transport. In the majority of the scenarios highway congestions will no longer increase after 2020, as a result of current road building programmes and saturation of car use. In scenarios with considerable economic and population growth, mobility will increase, especially freight transport. It is expected that congestion will remain primarily a problem of the Randstad area.
-

Tab. 4 The Netherlands: Growth scenarios for 2040
Source: Welvaart en leefomgeving [71]

Growth scenarios for 2040

	Global Economy	Strong Europe	Transatlantic Market	Regional Communities
Inhabitants	19.7 mio.	18.9 mio.	17.1 mio.	15.8 mio.
Number of households	10.1 mio.	8.6 mio.	8.5 mio.	7 mio.
Population above 65	23 %	23 %	25 %	25 %
Single-family dwellings	+ 1.9 mio.	+ 1.1 mio.	+ 1 mio.	+ 0.3 mio.
Multiple-family dwellings	+ 1.2 mio.	+ 0.6 mio.	+ 0.5 mio.	0.1 mio.
Expected changes on land use (2002 = 100 /%)				
Industrial plants	+ 43 %	+ 18 %	+ 23 %	- 3 %
Offices	+ 34 %	+ 19 %	+ 16 %	+ 1 %
Informal work locations	+ 46 %	+ 27 %	+ 25 %	+ 7 %
Agricutlure area	-15 %	-15 %	- 15 %	- 10 %
Nature areas (reserves)	+ 20 %	+ 25 %	+ 18 %	+ 22 %
Sport & recreation areas	+ 75 %	+ 48 %	+ 33 %	+ 18 %

2.20.2 Policies of interest

National Spatial Planning Programmes are published approximately on a ten year basis by the Ministry for Housing, Spatial Planning and the Environment (Rijksoverheid). The Programmes have an indicative character and focus on priority themes.

The most recent development is the *Nota Ruimte* (NR) programme[60], which was enacted by the Dutch parliament in 2006. The programme gives guidance for the national spatial development until 2020 and provides a vision for the spatial development until 2030. Overall objective of the programme is the realisation of a polycentric society and a withdrawal of central structures. "*Decentralisation as far as possible and centralisation only as far as necessary*" is the overarching motto of the programme. In order to better accomplish this goal responsibili-

60 http://www.vrom.nl/pagina.html?id=3410

ties for spatial planning were shifted from the national to lower administrative units (the provinces and municipalities). The decentralisation programme facilitates the development of new dwellings and commercial buildings in rural areas, in consistency with one of the programme's introductory postulates: *"Authorities have to set themselves up more as partners of committed individuals and enterprises, and increase dynamics instead of working against them with a multitude of regulations"* [61]. The issue of land take reduction is now highly individualised and under the responsibilities of the provinces [75].

The Nota Riumte programme has its own budget with 1 billion Euros until 2014, which is spent on 23 focus projects, many of which are related to the conversion of former industrial areas into mixed areas for housing and living[62].

Landscape fragmentation. The protection of landscapes from fragmentation is reflected in several spatial planning documents, among them:

- Order on Council Spatial Planning (AMvB Ruimte) reconfirms national aims to reduce urban sprawl and to establish a national ecological network to increase habitat connectivity.
- Action Programme against landscape cluttering (Beautiful Netherlands) aims to reduce development of new commercial zones by redeveloping the old commercial zones.
- Long-range programme for habitat defragmentation (Meerjarenprogramma Ontsnippering).

Brownfield redevelopment. In recent years several funding schemes for urban renewal and brownfield redevelopment were available at the national level[63]. In view of achieving a balanced polycentric development these responsibilities were moved to the local authorities. In 2008 the covenant on soil policy was enforced which (among other issues) defines the funding budget for urban renewal. The Urban Renewal Investment Budget[64] shall be decentralised from 2011 on, with a total funding budget of 242 mio. € for the period 2011 – 2014 [74].

2.20.3 Best practice

Randstad-Holland towards 2040 Vision and Implementation. The Dutch government has defined a long-term spatial planning strategy for the Randstad region with the overall objective to secure competitiveness and sustainability for one of Europe's largest urban regions. Though not explicitly targeted towards soil protection the vision puts strong emphasis on landscape protection, conservation and enlargement of recreational areas and improvement of urban living standards. It is expected that the Randstad agglomeration will need at least 500,000 new homes until 2040. Key objectives are (1) the securement of a "Green-Blue Delta" for landscape protection and recreational use, (2) the installation of "metropolitan parks" to enhance the attractiveness of urban areas, (3) and the optimal use of city centre space. The Randstad 2040 vision is supported by a broad implementation processes in cooperation of the Ministry of Housing, Spatial Planning and the Environment (VROM), provincial governments, municipalities and urban regions [76].

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61 " Overheden moeten zich daarbij meer gaan opstellen als partner van ondernemende mensen en bedrijven, en de dynamiek versterken in plaats van deze tegen te gaan door een veelheid aan regels."

62 Descriptions are available at the VROM website: http://www.project.vrom.nl/project.asp?code_prjt=10769&code_prgm=32

63 The BELSTATO urban renewal fund, with 363 million Euro per year available over the period 1990 – 2005, The Intrafunds of the Ministry of Transport, Public Works and Water Management, and the VINEX covenants with approximately 408 million Euro budgeted for 1995-2005 targeted to the remediation of contaminated land.

64 ISV, Innovatie Programma Stedelijke Vernieuwing

Innovative housing. In the period 2000 to 2004 the programme for innovative urban renewal (ISV, Innovatie Programma Stedelijke Vernieuwing) funded a series of innovative projects for innovative housing solutions. Key objectives were to meet the housing needs of today`s society, namely housing with high living standards, green space and perfect infrastructure but at the same time at affordable prices and low soil consumption.

The IPSV programme was stocked with 36.7 million Euro and funded more than 150 innovative housing projects. A description of all funded projects can be found on the website of the Ministry for Housing, Spatial Planning and the Environment[65]. Furthermore a series of guidelines were published in order to spread information on innovative housing, among them the guidelines "*Gaining space*" with special focus on inner urban development, [77].

Fig. 50 Innovative housing: examples of private housing initiatives.
Left: Semi detached houses with sun panels for photovoltaic and heating. Right: Row houses with joint landscaping.
Source: VROM [77]

2.20.4 Conclusions

Dutch soils are under considerable pressure since population and economy are growing continually and the state of sealing is already outstandingly high with 8 %.

The principle of sustainable spatial development was already adopted in the 1990ies and inner urban development was a planning priority up to 2005.

With the publication of the spatial development programmes *Nota Ruimte* and *Randstad 2040* an integrated approach was adopted, giving clear priority to polycentric developments, the strengthening of sustainable mobility, climate change aspects (in particular flooding) and protection of landscapes.

Experience with innovative housing, brownfield redevelopment and improvement of urban living standards is very advanced, as can be seen in the numerous projects and guidelines in this respect.

65 http://www.project.vrom.nl/lijstweergave.asp?code_prgm=1

2.21 Poland

Geography. Poland is an unbroken plain reaching from the Baltic Sea in the north to the Carpathian Mountains in the south. Only 3 % of the country is covered by mountain regions with elevations higher than 500 m. Major land uses are agriculture 59 % and forestry 29 %,

Demography. In 2010 Poland's population amounted to 38.1 mio inhabitants. Poland's population was rapidly growing until independency. Between 1993 and 2007 population is slightly decreasing, mainly due to outmigration. In this period some 600,000 inhabitants were lost. However, Poland seems to have recovered from this trend since from 2007 slight population increases can be observed.

Population density is on average at 122 inhabitants per km², with an average urban population density of 1,105 capita per 1 km² and 50 capita per km² in rural areas. 61.5% of the Polish population lives in urban areas, a number which is slowly diminishing. The largest city is Warszaw with 1.7 million inhabitants followed by Krakow and Lódz, both having more than 700,000 inhabitants.

2.21.1 Land take and sealing

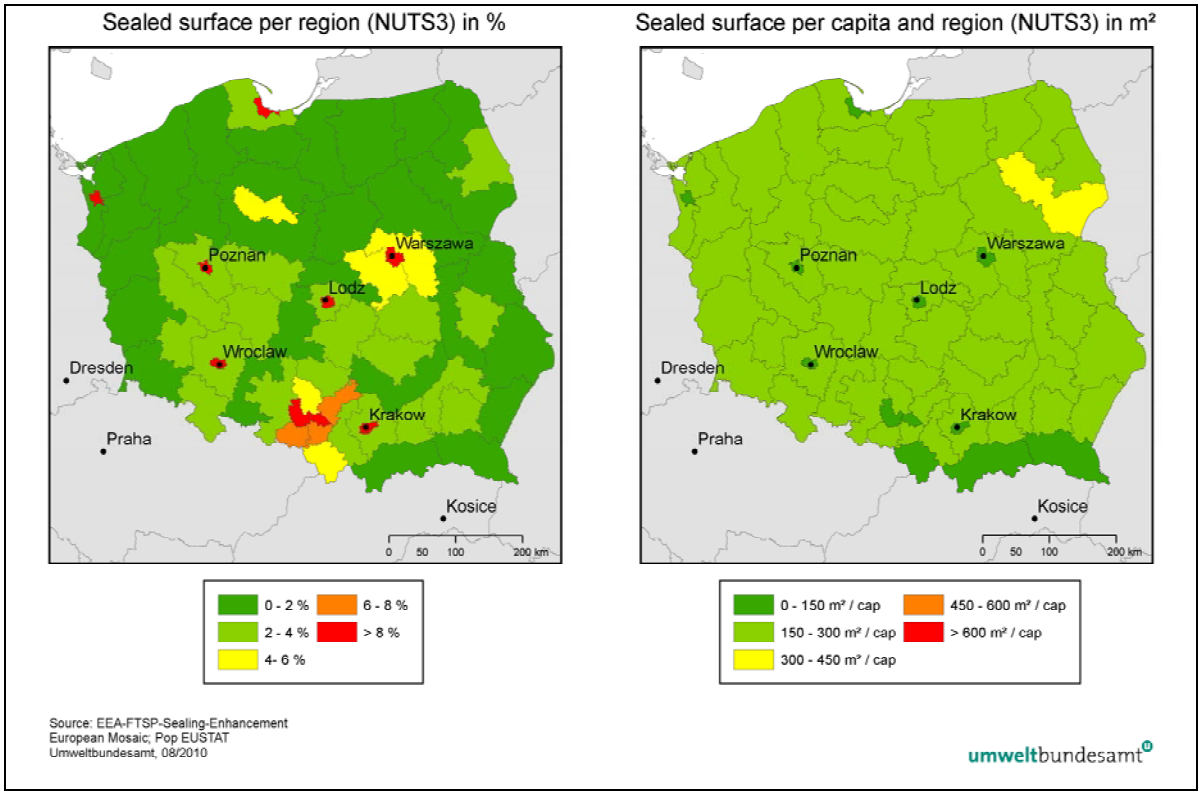

Fig. 51 Poland: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Soil sealing is not exactly monitored in Poland. Between 2003 and 2007 the amount of built-up area (including residential areas, industrial areas, recreational areas, and transport area)

increased by 2.5 % whereas no population growth was observed[66]. With regard to urban sprawl the most affected regions are the Warsaw agglomeration, the Katowice agglomeration (with cities between 60,000 and 3 mio inhabitants), and the suburbanisation around Poznan, Wrezlaw, Krakow and Stetin.

Comparison with other EU Member States. Poland is among the EU Member States with the lowest average annual land take since 1990. In the period 2000 to 2006 Poland's artificial surface increased by 1 %, on the other hand population was slightly shrinking with minus 1.3 %. Only the region Poznan was affected by a high increase of artificial surface between 2000 and 2006. The amount of sealed surface is about 12 % lower than the EU average.

The outlook for the future predicts a major increase in road networks and passenger transport. For the period 2008 to 2012 about 4,000 km highways and expressways are planned and an increase of 6 million vehicles is expected until 2020[67]. These plans would result in an additional sealing rate of 8,000 hectares per year without considering the additional need for new parking areas. A realisation of these plans would result in annual sealing rate being five times higher than between 2000 and 2006 [78].

2.21.2 Policies of interest

Spatial planning. The key document for spatial planning is the *National Act for Spatial Planning* (2003, amended in 2009)[68]. The reduction of urban sprawl and soil sealing is not mentioned as a priority issue - to some extent the problem of suburbanization around large urban agglomerations is mentioned.

The *National Spatial Arrangement Policy* is a strategic planning document for the period 2008 – 2033, which was prepared by spatial planning experts for the Ministry of regional development. The document is a spatial planning outlook for the future and among other highlights the problematic of suburbanisation around prosperous cities and shrinking regions in rural areas[69].

Spatial planning is to some extent under the responsibility of the Ministry of Regional Development, but also the Ministry of Infrastructure. The issues soil sealing and urban sprawl are not yet fully recognized in policy preparation and there is a confusion of competences.

Protection of the best land. The *Law on Protection of Agricultural*[70] strictly protects top agricultural land in rural regions. Only 14 % of the total agricultural land in Poland is of high quality. Key objective of the law is to give fallow lands priority for urbanization purposes.

The law distinguishes between 6 soil classes. The conversion of high quality soils (classes I-III) is charged and the amount of the fee depends on the soil class and on area size of the

66 Central Statistical Office

67 Ministry of Infrastructure (2005): National Transport Policy for 2006 – 2025, , approved by the Council of Ministers on June 29th 2005 (http://www.eukn.org/binaries/poland/bulk/policy/2005/12/national-transport-policy-for-2006---2025.pdf)

68 Ustawa o planowaniu i zagospodarowaniu przestrzennym (translation: Spatial Planning and Spatial Management Act of 27 March 2003) last changes dated 2010-02-15

69 Ekspercki projekt koncepcji przestrzennego zagospodarowania kraju do roku 2033 (Warszawa, grudzień 2008) / translation: Expert Study on Framework of National Spatial Arrangement Policy
download: http://www.mrr.gov.pl/rozwoj_regionalny/poziom_krajowy/polska_polityka_przestrzenna/koncepcja_polityki_przestrzennego_zagospodarowania_kraju/Documents/e38efc190a3548c8a3708a248d551aa2AngielskiskrtKPPZKFORMAT20504_2.pdf

70 Ustawa o Ochronie gruntow rolnych i leśnych z 3 02. 1995 / translation: Act on agricultural and forestry land protection, 3.02.1995).

given land.

Land use changes have to be integrated into the local spatial plans by the local administration. For areas larger than 0.5 hectare the opinion of the regional administration (Voivodeship) is required and approval of the Ministry of Agriculture and Rural Development is needed. In the case of forest land the Ministry of the Environment is in charge.

Agricultural soils within urban administrative borders are currently excluded from the system.

Brownfield redevelopment. There are no specific programmes at the national level to redevelop brownfields. However, abandoned industrial land (i.e. closed down coal mines, metallurgic plants, steel mills, other large production plants and dump sites) exists in great amounts in particular in the Silesian region, a former coal mining region in economic transition. In 2008 The Silesian regional (voivodeship) published an official document on brownfield redevelopment, which has an indicative character "*Voivodship Programme of Post-Industrial and Degraded Areas*"[71]. The document distinguishes between two brownfield categories (1) highly contaminated sites, where the protection of the environment and human health shall be secured, and (2) sites with a good conversion potential. Guidance is provided how to deal with both categories.

2.21.3 Best practice

Inner urban development. In 2005 the Public Private Partnership Act[72] was enforced. Based on this legal instrument it was possible to finance the regeneration of run down historic city centres, to improve the attractiveness of these cities and secure local jobs as this was the case in the cities Bielsko Biala and Sopot [79].

Brownfield redevelopment. Several EU funded brownfield redevelopment projects are currently in realisation. In the city of Bygoszcz the conversion of a former roofing paper factory into a recreational area is in realisation (project COBRA-MAN, see also chapter on Networks), in the city of Piekary a large and highly contaminated area of a former industrial plant will be developed into a commercial park (project CIRCUSE see also chapter on Networks).

Brownfield promotion. In order to enhance the reuse of brownfield sites Silesia has initiated an investor friendly internet portal (Invest in Silesia) where a description of all abandoned industrial sites can be found. The portal is multilingual and includes an overview of all available brownfield sites, including information on the size of the sites, location, infrastructure, information with regard to ownership, information concerning contamination and performed investigations etc [80].

2.21.4 Conclusions

Up to now soil sealing and urban sprawl are not perceived as a major problem in Poland. For the next decade a considerable increase of annual soil sealing can be expected due to the planned expansion of road networks and the resulting increase of private transport.

In the past contaminated land and conversion of abandoned industrial land have been of major concern and remain to be of importance. The Silesian region is most affected of this

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71 Wojewódzki Program Przekształcen Terenów Poprzemysłowych i Zdegradowanych (2008) / translation: Voivodship Programme of Post-Industrial and Degraded Areas' Transformation, Katowice, 2008.

72 Ustawa o partnerstwie publiczno-prywatnym z dnia 28 lipca 2005), Dziennk Ustaw Nr 169 / translation: Public Private Partnership Act of 28th June 2005

phenomenon. The Silesian Voivodeship is in the beginning phase of establishing a comprehensive brownfield redevelopment scheme, the first steps have already been made; i.e. the publication of an official guidance documents for brownfield redevelopment and the establishment of a brownfield inventory on the internet.

Agricultural soils of the best quality are to some extent protected, since their conversion into building land is connected to a fee.

2.22 Portugal

Geography. The North of the main land is mountainous and rainy, characterized by many small farms and vineyards. The central eastern area consists of mainly small and medium-sized farms, with some mining and light industry. In the greater Lisbon area firms and industry are found while the south is dry and dominated by the tourism sector. The Azores and Madeira are autonomous regions of Portugal with their own politic-administrative statutes and government.

Demography. Portugal's population is constantly growing and amounts today to more than 11 mio. inhabitants. The largest cities are Lisbon with about 560,000 and Porto with about 220,000 citizens. The wider agglomeration of Lisbon includes about 3.4 mio. inhabitants and 38 % of the population live in the wider agglomerations of Porto and Lisbon.

2.22.1 Land take and sealing

Based on available data (CORINE data and EEA sealing map) Portugal's artificial surfaces are to 90 % sealed (see also Fig. 4). On the one hand are indices referring to artificial surfaces rather moderate compared to the EU average and on the other hand are data referring to soil sealing about one third higher than the EU average. One reason for this phenomenon might be the fact that Portugal's road infrastructure is among the densest in Europe with the highest number of km of roads per inhabitant and area.

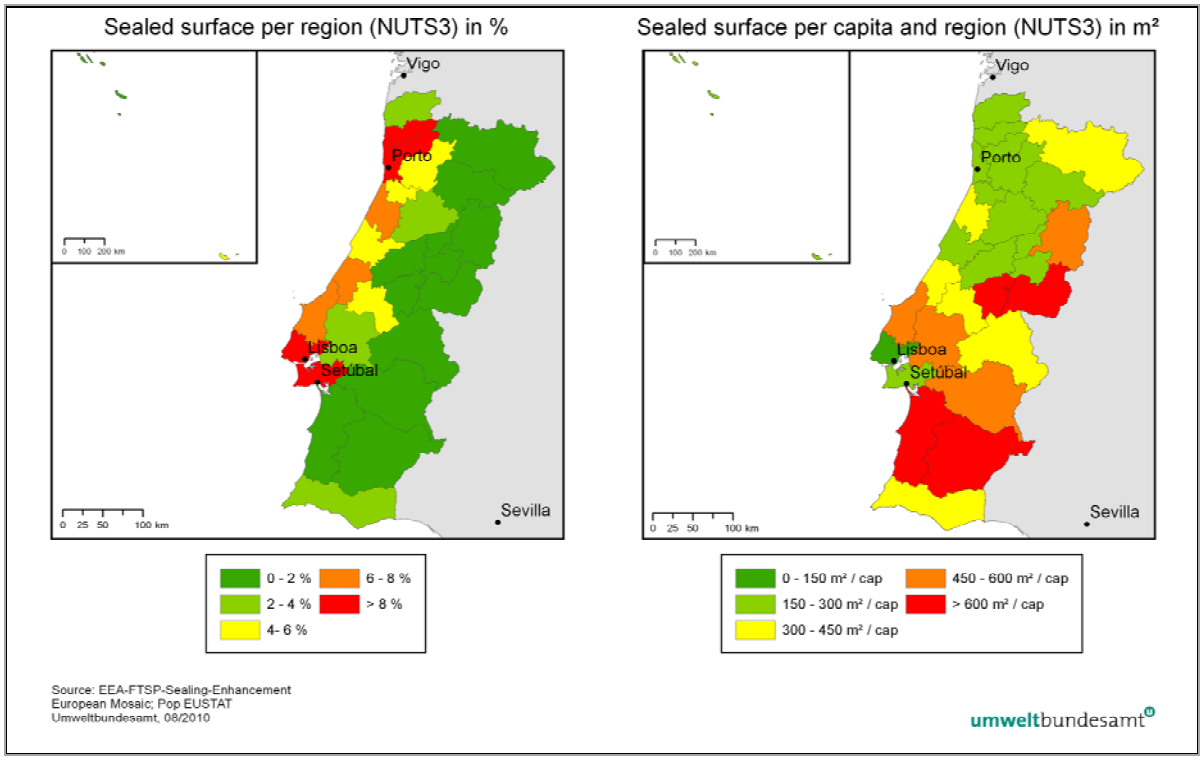


Fig. 52 Portugal: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Portugal was subject to massive urban sprawl between 1990 and 2006. The amount of artificial surface almost doubled and the rate for annual land take per capita ranged between 4 and 5 m² per capita, which is among the highest in the EU. Massive urban sprawl of recent years affected primarily coastal areas. Growing land take affects the urban agglomerations of Lisbon, Setubal and Porto where people tend to move out of the city centres towards greener suburbs. In the Algarve in the very South of the country the trend of second homes for foreigners is noteworthy to mention, where already 30 % of existing households are second homes. And finally the expansion of the road infrastructure massively contributed to further sealing [83].

2.22.2 Policies of interest

Uncontrolled urban growth, in particular along coastal areas, run-down city centres and shrinking rural areas are key issues of concern and also central issues of the three central spatial planning documents [82]:

- The central programming document for spatial planning is **National Sustainable Development Strategy** 2005-2015 (NSDS), approved in August 2006. The document makes specific reference to reversing the trend towards extensive and low quality urban growth and encouraging urban re-qualification and recovery of degraded areas, promoting higher standards of quality of life.
- The **National Programme for Spatial Planning (NPSP)**, approved by the Parliament in September 2007 establishes the major options that are relevant to the organisation of the country, in line with NSDS and with the values encompassed by the concept of regeneration. At a regional level, this Programme is realised by means of Regional Spatial Planning Schemes, and at municipal level, by the Municipal Master Plans. Specific objectives are to re-qualify urban areas, to preserve available natural resources and to better co-ordinate growth.
- **Polis XXI**, approved in March 2007, is the cities policy programme for the sustainable development and national cohesion of the Portuguese cities. It is constituted by a set of integrated urban policy instruments aimed at promoting urban regeneration, competitiveness and innovation through networking as well as at improving quality of life and environment in the cities. It highlights urban regeneration as an essential dimension of cities cohesion, determinant for the quality of life. Polis XXI will be implemented during the 2007-2013 period, mainly through private-public partnership contracts.

2.22.3 Best practice

Portugal has developed several urban renewal projects and applied for funding within the JESSICA funds – a funding line of the European Structural Funds with specific focus on urban renewal (see also chapter 6, page 198). The JESSICA funds will in total provide funding in the range of 100 mio. Euro for urban renewal projects in Portugal. This amount will represent approximately one fifth of total investments, which will be shared by the public and the private sector. Most noteworthy are the renewal of the down town quarters Morro Sé and Cardosa.

Morr Sé renewal project. Key issues in the Morro Sé quarter are rundown buildings, inferior quality of public spaces, and a high vacancy of dwellings. Major objective of the renewal pro-

ject is to improve the living conditions for the population and to plant new dynamics in the quarter, by establishing residents for students and tourists. Planned renewal activities foresee a hotel, a residence for elderly people, public space requalification, and student residencies. Planned investments will amount to 40 mio Euro, which will be shared between the private sector (45 %), the public (36 %), and the JESSICA funds (19 %).

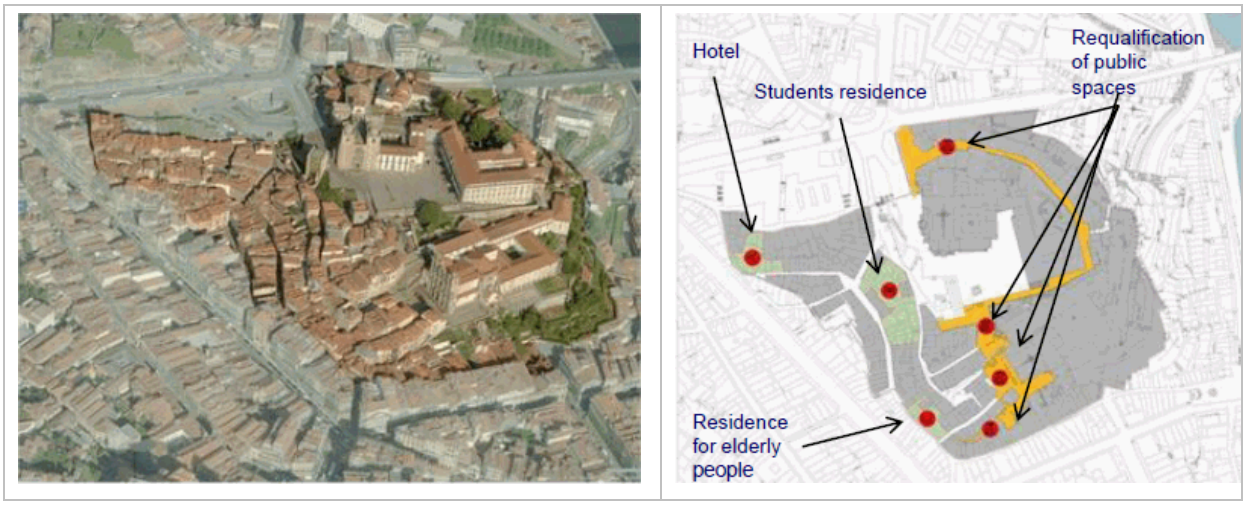


Fig. 53 Portugal: The Morro Sé renewal project in Porto.
Source: European Investment Bank [82]

Cardosa renewal project. In the very heart of Porto the rundown Cardosa quarter will also be subject to an urban renewal scheme. Key objective is to make the quarter more attractive. Planned actions include the construction of a 4 or 5 star hotel, public parking and the establishment of residential rehabilitation.

2.22.4 Conclusions

Since 1990 Portugal has been subject to massive urban sprawl, affecting above all coastal regions in the vicinity of urban agglomerations and the very South of the country. Growing suburbs and second homes in touristic regions are major land consumers. Major consequences are run down city centres and environmental problems along coastal areas.

Urban renewal is of central political concern. Several policy schemes for better controlled urban planning have recently been published. With the support of the European Regional Development Funds, Portugal plans to invest in total 1 billion Euros in urban renewal projects.

2.23 Romania (short country profile)

Geography. The natural landscape is almost evenly divided between mountains (31 %), hills (33 %), and plains (36 %). The Carpathian Mountains are of low to medium altitude and are no wider than 100 kilometers. Enclosed within the great arc of the Carpathians lie the undulating plains and low hills of the Transylvanian Plateau - the largest tableland in the country and the centre of Romania. Beyond the Carpathian foothills and tablelands, the plains spread south and west. The land here is rich with chernozemic soils and forms Romania's most important farming region. Romania's lowest land is found on the northern edge of the Dobruja region in the Danube Delta.

Among the EU Member States Romania is the richest with regard to natural resources. To name a few assets, (1) Romania has one of the largest areas of undisturbed forest in Europe, amounting to 10,000 km^2, (2) there are in total 13 national parks of exceptional size and diversity, (3) and three biosphere reserves the Retezat National Park, the Rodna National Park, and the Danube Delta, being the largest and least damaged wetland complex in Europe, covering a total area of 5,800 km^2.

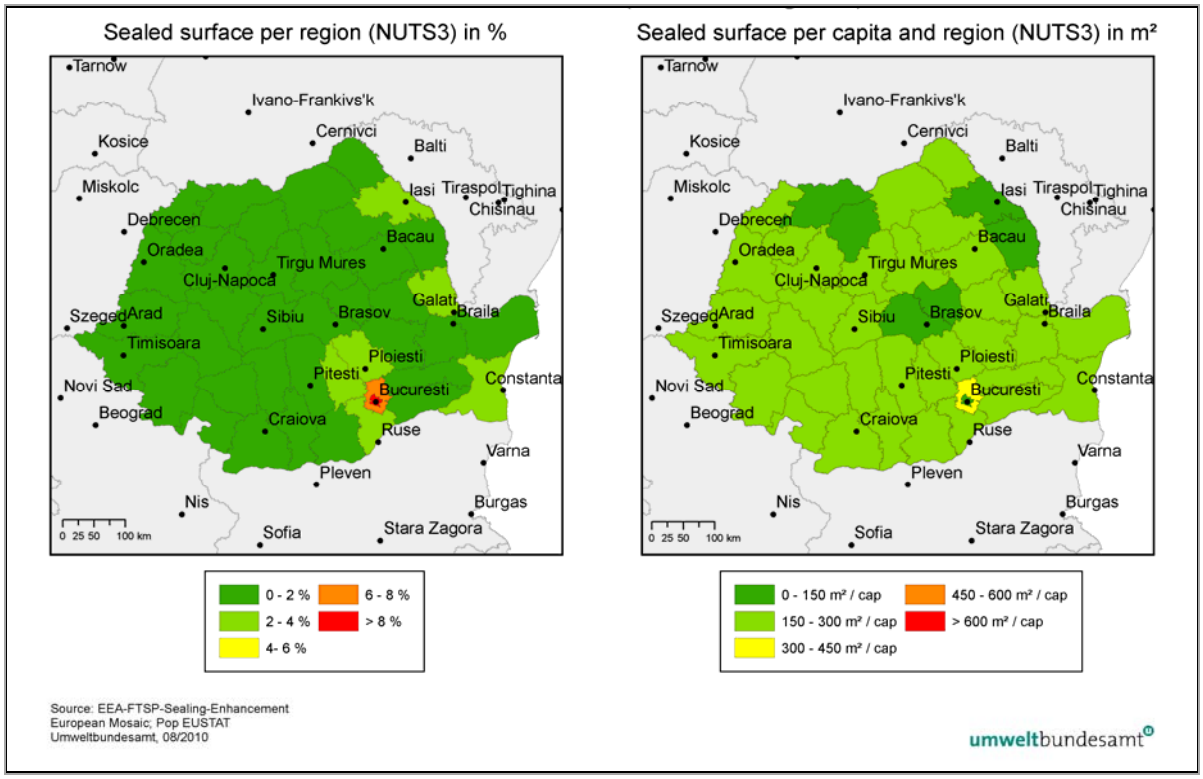


Fig. 54 Romania: Soil Sealing per region in 2006
Source: EEA, EUROSTAT

Demography. Romania has lost 8 % of its population since 1990 and the trend of emigration is expected to continue. In particular young people and well educated persons are leaving the country and leaving a substantial gap for the local economy. Movements from rural regions to urban regions are also significant. Today many rural regions in Romania lack appropriate human resources to maintain basic infrastructure like schools, hospitals and nursing homes. The largest urban agglomerations are above all Bucarest with about 2 million inhabitants. All other cities are considerably smaller with less than 300,000 inhabitants.

Land take and sealing. In 2006 the share of sealed surface amounted to 1.6 % which is about one third below the EU average, while the amount of artificial surface is 6.3 % - far above EU standard. This can probably be explained by the large number of quarries and mines, many of which were closed since 1990.

It was not possible to obtain any further information on measures to reduce soil sealing or land take.

2.24 Slovakia

Geography. The total territory covers about 49,000 km² with key land covers being agricultural land (49 %) and forest (41 %). The Northern part of the country is rich in forests and dominated by the Carpathian Mountains with the highest peaks in the Tatras (Gerlach 2,655 m) close to the Polish border. The South-Eastern parts of the country are covered mostly by lowlands: Eastern Slovak Lowland, Záhorská Lowland and Danubian Lowland which is the most fertile and famous one. Largest rivers are the Danube, the Morava, and the Tissa river at the Hungarian border.

Demography. With 5.4 million inhabitants Slovakia belongs to the smallest EU Member States. Unlike other new EU Member States from Central and Eastern Europe Slovakia was not affected by massive outmigration after independency. Since 1990 the Slovak population remained stable even showing slight increases. Average population density is at 110 capita per km², with the most populated area being the Bratislava agglomeration (430 cap/km²). Dominant settlement structures are small towns and villages. 29 % of the Slovakian population lives in cities with more than 50,000 inhabitants.

2.24.1 Land take and sealing

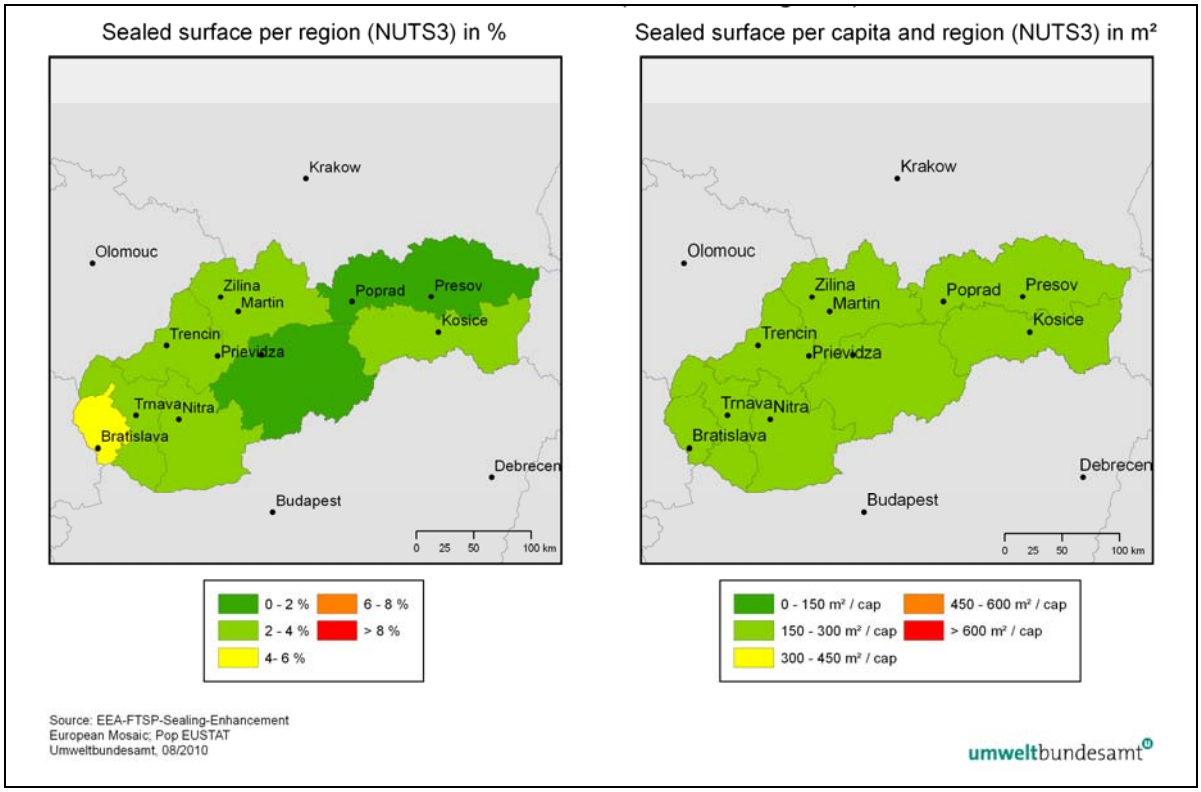


Fig. 55 Slovakia: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Slovakia's landscape is characterised by a balanced mix of forests, agriculture, small and medium sized cities and soft mountainous regions. The country underwent an enormous economic transition process, which started in 1990 with the independence of the Czechoslovakia and was further intensified after 1993 with the independence of the Slovak Republic.

Among the new EU Member States the Slovak Republic (together with Slovenia) has the best economic development. The Slovak government focused on attracting foreign investments by introducing business friendly policies such as labour market liberalization and a 19 % flat tax.

Comparison with other EU Member States. In 2008 built-up area covered about 4.5 % of the entire territory, the amount of artificial surface per capita is 23 % higher than the EU average and increased by 7 m² and person between 2000 and 2006. With regard to sealed surface per capita Slovakia is with 214 m^2 slightly (6.5 %) above the EU average.

Between 1996 and 2008 the total surface of built-up areas increased by 18 %, whereas population growth amounted to only 10 %. (see also Fig. 56). The Bratislava region is the most populated and densely built region in the Slovak Republic and was subject to massive building activities in recent years. Due to the enormous economic growth land take is estimated to amount to 5 hectares per day in the period 1990 - 2008 [84].

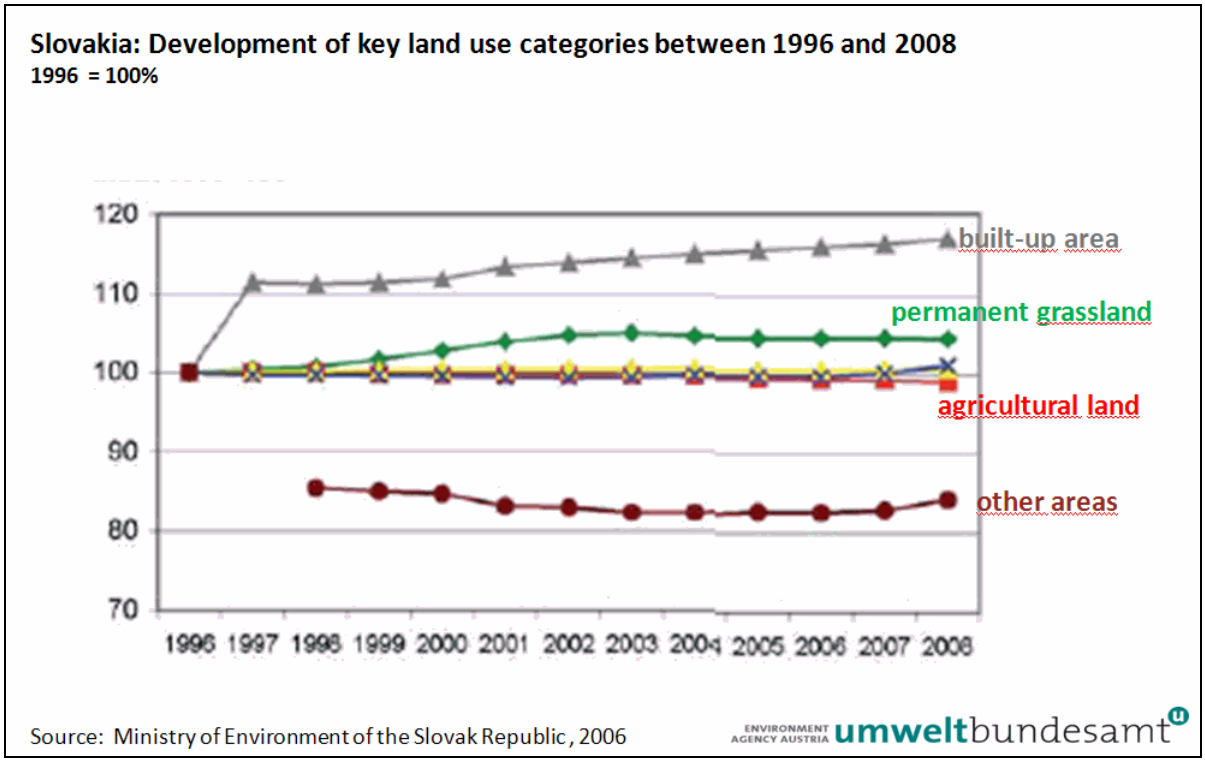


Fig. 56 Slovakia: Development of key land use categories between 1996 and 2008.
Source: Ministry of the Environment, 2008, [85]

2.24.2 Policies of interest

Protection of the best land. In 2004 the Act on Protection and Utilisation of Agricultural Soil[73] was enforced which aims to protect the best agricultural land and to steer new developments to soils with lower quality. In total there are 9 soil classes and the best four classes are protected. The conversion of such land into building land is charged with a fee for each square meter of lost soil, which ranges between 6 € and 15 € per m². More details can be

[73] Act No. 220/2004 Coll. on Protection and Use of Farmland

found in the chapter on compensation systems (see also page 180).

Public green. Public green areas in cities are considered as important factor for the quality of living in urban areas and to make sure that citizens do not move to suburban regions. The Statistical Office of the Slovak Republic is in charge for monitoring public green areas. In 2005 public greens amounted to 21 m² per inhabitant. Fig. 57 refers to the trend in public green between 1996 and 2005, no decreasing trend was observed [86].

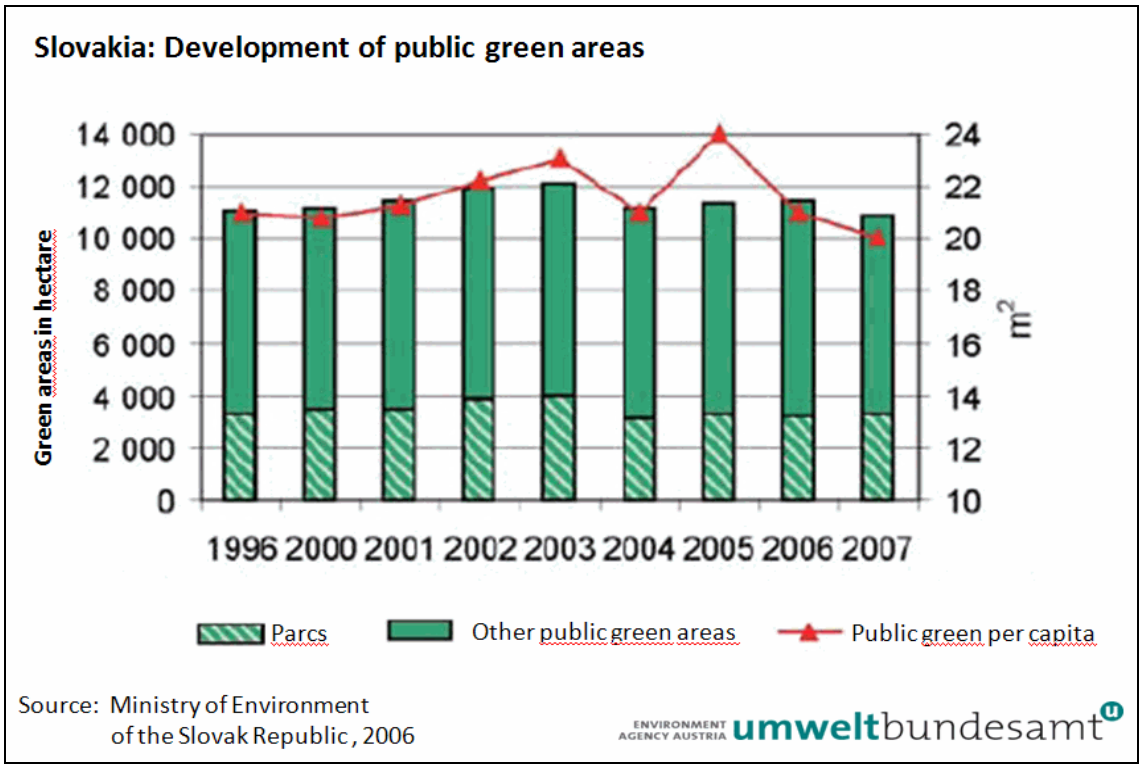


Fig. 57 Slovakia: Development of Public Green Areas
Source: Ministry of the Environment, 2007, [86]

Spatial Planning. The main legal instrument is the *Act on Spatial Planning and Building Code* (Code No. 50/1976 Zb), which makes a clear reference to sustainable spatial planning and the protection of natural resources. In the Slovak Republic all activities concerning urban sprawl must be put in the local planning documentation, especially when it concerns developments on agricultural land in the outer area of a municipality. All procedures are regulated within Spatial Planning and Building Code, which shifts the rights to the municipalities (being responsible for local plans and zonal plans).

The key principles of spatial planning are laid down in the *Slovak Spatial Planning Perspective (KURS)*, which is a binding planning document and considers a longer planning horizon of 15 to 20 years. The planning goals of the latest KURS were published in 2001 and include a clear commitment to polycentric settlement development with good infrastructure access, sustainable development, and the protection of environment and cultural heritage.

Brownfield redevelopment. Currently there are no specific programmes with regard to brownfield redevelopment. Awareness with regard to brownfield redevelopment is growing

and several EU funded projects were initiated. Slovakia is currently active in several EU funded projects with specific focus on urban soil management, inner urban development and reuse of brownfields (see also best practice).

2.24.3 Best practice

EU operational programme "Economic growth and competitiveness". There was a call from the Slovak Ministry of Economy on "Revitalisation of Urban Areas". Under this call it was possible to realise the development of a new Technology Park on the premises of a former glass factory near Kosice. The Technology Park will be completed in the period 2010 to 2011 and shall primarily attract small and medium sized enterprises and research oriented business operations. The area is already to 50 % booked and can be considered as a success story for the structural funds, since the project saved agricultural land and will support economic stability in the region.

Bratislava - positive implementation of planning instruments. In the area of vineyards under the Lesser Carpathian Mountains there is a big interest of developers to build residential areas. Local government would like to agree with the conditions of the developers to take quite large area of the vineyards and have quite a high index for the density and height of built-up areas but this was in contradiction with the regional plan and the Regional office for Construction did not agree and returned the local plan back for making the changes in accord with the approved regional plan.

Efficient land management in the surroundings of the city Trnava. The city of Trnava is confronted with shrinking population on the one hand and with over frequented infrastructure - in particular kindergartens, schools and hospitals – on the other hand. The settlement of large industrial plants of the automotive and telecommunication industries and the planned enlargement of the nuclear power plant of Bohunice have led to a continuous increase of workers, preferring affordable housing in the small villages outside the city. Besides that, there is a general trend to leave the city and live in single family houses. The city planners have now started an initiative to co-operate with the small villages and to make a regional inventory of underused brownfield sites, of which there are plenty - in particular former facilities of agro industry. Key objective is to reduce future urban sprawl as far as possible and direct new developments to already developed land. The initiative is part of the EU funded project CIRCUSE (Interreg – Central Europe).

2.24.4 Conclusions

Since 1990 considerable developments were realised in Slovakia, including above all major infrastructure and large industrial plants. Due to the fact that Slovakia has a very strict soil protection policy it was possible to steer developments to less valuable soils. Urban sprawl will continue to be a key issue in Slovakia, since living standards are growing continuously and the demand for single family housing is in the beginning phase.

Structural Funds. Like all new Member States Slovakia is highly dependent on funding from the EU Structural funds[74]. Contradictions between key environmental objectives and the policies of the EU structural funds are perceived, since major amounts of the European Structural Funds[75] are allocated to transport infrastructure, in particular for road and train net-

[74] All Slovakian regions - with the exception of the Bratislava region -are eligible to "Objective 1" funding.

[75] In the funding period 2007 – 2013 about 20 – 38 % of the total ERDF budget is dedicated to transport infrastructure
In the funding period 2000 – 2006 about 33 % of the funding budget was allocated to basic infrastructure .

works, railway stations and airports. High performance roads always result in more traffic and increase commuting distances. In recent years developments related to the structural funds were usually directly related to soil consumption and additional production of green house gases. Changes of the structural funds are already visible and should be further steered in the direction of sustainable development; such as investments in inner urban developments, brownfield redevelopment, renewable energies, public transport, and energy saving projects.

Spatial Planning. Slovakia considers three spatial planning levels, the national level, the regional level, and the municipality level. There is a planning gap between the municipalities (which are usually very small) and the regions which are quite large and include several cities. A more logic definition of planning regions would be recommendable. Slovakia includes a great number of small cities with 20,000 to 50,000 inhabitants. The definition of “mircoregions”, like for example a medium sized city plus surrounding municipalities would make more sense.

2.25 Slovenia

Geography. Slovenia covers an area of 20,273 square kilometres, of which about two thirds are covered with forest and about 28 % with agricultural land. Slovenia is characterised by geographical diversity on a very small territory, including the large planes around Ljubljana and Celje, mountainous regions and coastal regions. There is a prevailing tendency towards a strong concentration of power in the national centre on the one hand and fragmentation into a large number of small municipalities.

Demography. In 2010 Slovenia's population exceeded 2 million. The average population density is about 102 inhabitants per km². Apart from Lubljana with 270,000 inhabitants there is no other city with a population of more than 100,000 inhabitants. In Slovenia, there are 5961 small settlements, a quarter of which have less than 50 inhabitants and there are only 7 towns with more than 20,000 inhabitants. Dense settlement structures in the valleys and plains are typical. The population in the broader hinterland of larger towns has doubled in the last three decades.

By the second half of the 20th century, Slovenia had undergone an intense transformation from a rural to a non-agrarian society. Population growth, however, was not as great as elsewhere in Europe, owing to emigration and, until the 1970s, the absence of immigration. By the early 21st century, migration flows in and out of Slovenia had nearly balanced each other out. Slovenia's birth rate is among the lowest in Europe

2.25.1 Land take and sealing

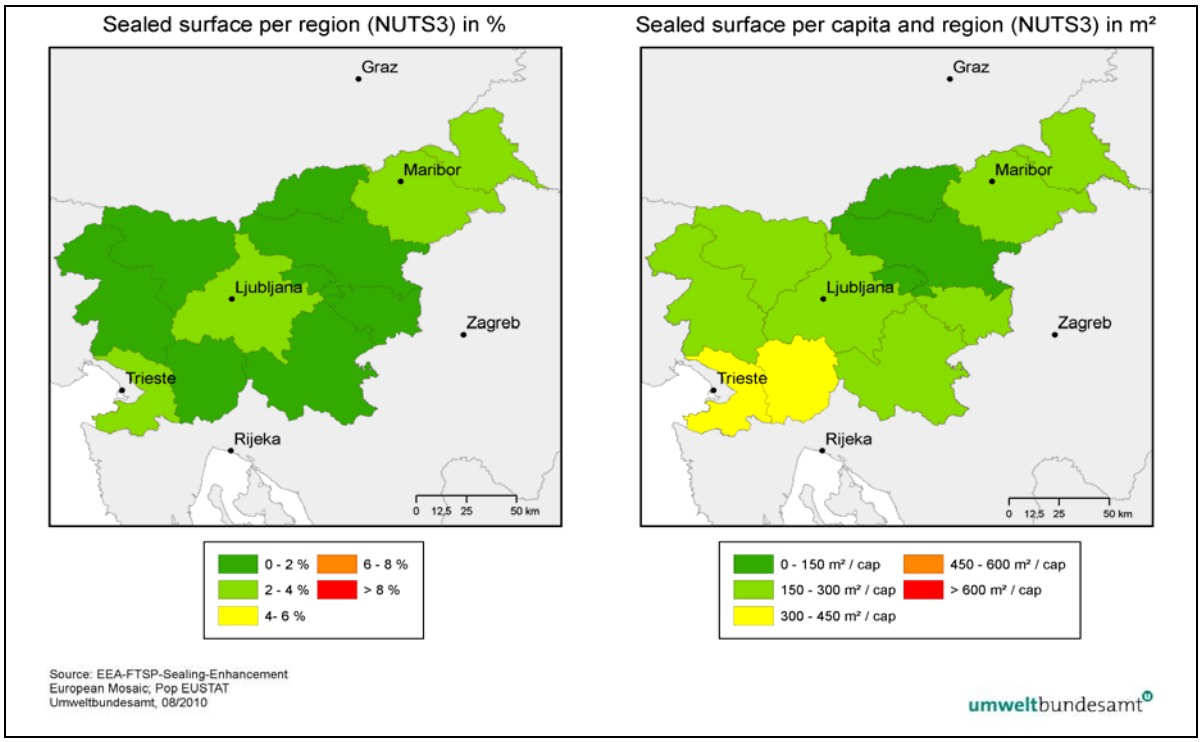


Fig. 58 Slovenia: Soil sealing per region in 2006
Source: EEA, EUROSTAT

Comparison with other EU Member States. The amount of artificial surface per capita is

about one third below the EU average. Increases between 2000 and 2006 were rather moderate compared to other EU countries. The amount of sealed surface is 10 % below the EU average.

Shrinking areas prevail in the mountain regions, they encompass almost 40% of the Slovenian territory. Population in these areas can no longer maintain both the local infrastructure and the cultural landscape. The consequence is a pronounced overgrowing of the landscape with forest, which already covers more than 56 % of Slovenian territory.

Tab. 5 Average annual land take in Slovenia between 1996 and 2006. Source: [89], CORINE Land Cover Date of the years 1995, 2000, and 2006

	uptake in ha			
types of human activity	**1996-2000**	**2000-2006**	**total 1996-2006**	**per year**
land uptake by housing, services and recreation	11.37	151,34	162.71	16.27
land uptake by industrial and commercial sites	43.52	68,22	111.74	11.17
land uptake by transport networks and infrastructures	83.73	694,05	871.61	87.16
land uptake by mines, quarries and waste dump-sites	177.56	177,50	261.23	26.12
total artificial land cover uptake	316.18	1,091.11	1,407.29	140.70

In Slovenia – like in most European countries – population is hardly growing whereas building activities and land take are growing much faster. Between 1971 and 2007 the Slovenian population increased by 8 %, where as the number of dwellings increased by more than 70 % (see Fig. 59). The average annual land take between 1996 and 2006 amounted to approximately 140 hectare per year (or 0.7 m² per citizen and year), which was very moderate in comparison to other countries (see also Tab. 2).

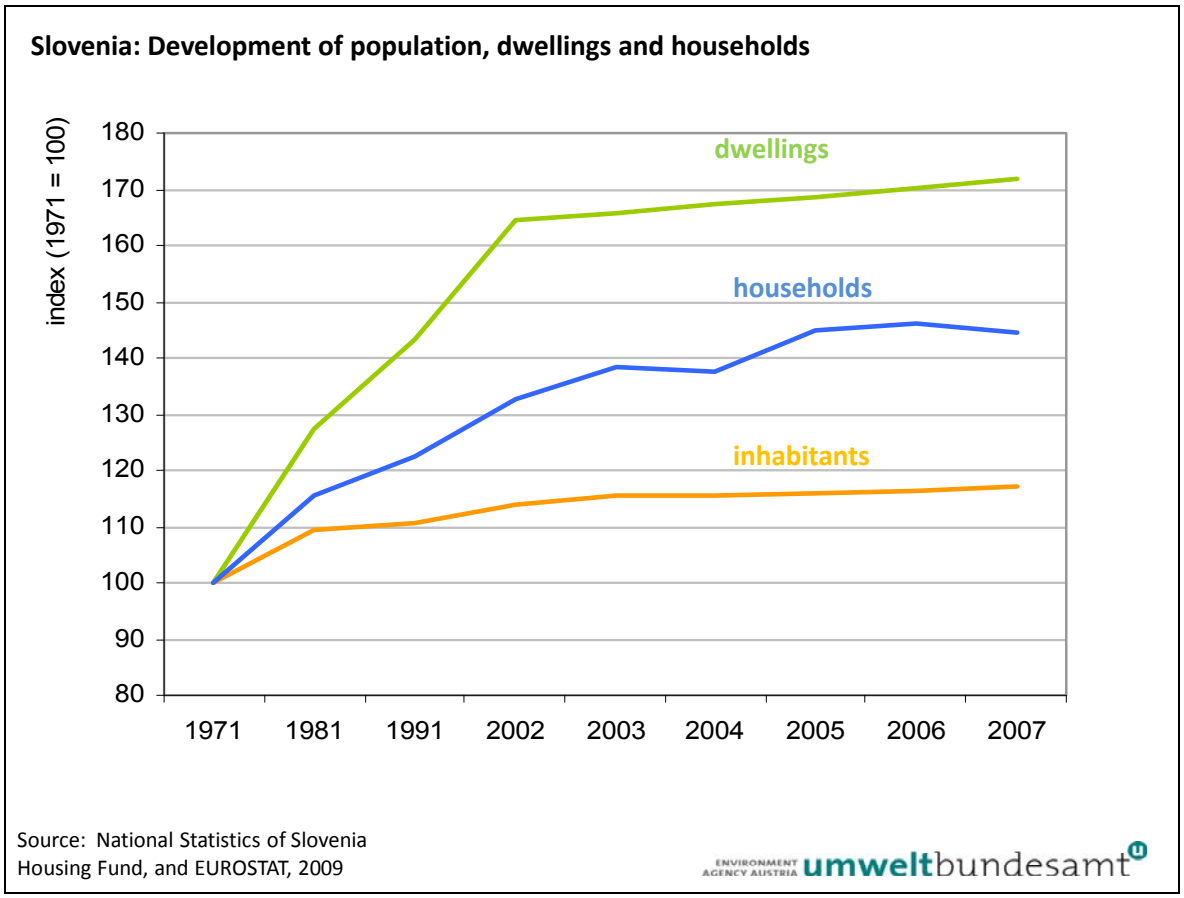


Fig. 59 Slovenia: Development of population, dwellings and households between 1971 and 2007.
Source: Census data 1931-2002 of the National Statistics of Slovenia, Housing Fund, 2009, EUROSTAT, 2009

In 2008 the Ministry of the Environment published the report *Environment in the palm of your hand*, which reports on the progress with regard to environmental management [90]. The report confirms the above statement and refers to the successful spatial management policy which focuses on inner urban development *"In spite of the relatively high economic growth, only a minor increase in urban housing and commercial areas was observed. A decrease in the number of household members and thus increased demand for housing areas per person is a phenomenon which is evident in a significant increase of the housing areas in the majority of European countries.* ***In Slovenia, such development was suppressed by the introduction of the measures in spatial planning which promoted construction of housing units mostly inside urban areas****. The dispersed settlement structure where a half of the population lives in small settlements with fewer than 2,000 inhabitants can denote a number of small changes that are not detected by the CORINE Land Cover methodology"* [90].

2.25.2 Policies of interest

Two central documents govern spatial planning in Slovenia.

1/ In 2004 the Ministry of the Environment, Spatial Planning and Energy published the *Spatial Development Strategy for Slovenia*, which defines spatial planning priorities for Slovenia under full consideration of sustainable development [91]. The document can be considered

as very innovative compared to similar documents in other countries: it establishes the principle of sustainable spatial development, it requires an integrative approach to achieve this goal, and it gives clear directions regarding land use efficiency, reduction of urban sprawl, and land efficient development of polycentric structures.

2/ Three years later the National Spatial Planning Act was enforced, which clearly regulates spatial planning in Slovenia [92]. The plan refers to 11 key objectives, five of which explicitly refer to the reduction of urban sprawl and efficient land use:

- sustainable development in space and the efficient and economic use of land,
- renewal of the existing infrastructure, which has advantage ahead of the construction of new infrastructure,
- preservation of characteristic features of space,
- rehabilitation of brownfield sites, and
- protection of the environment, natural resources, and nature conservation;

The annual land take per inhabitant amounts to less than 1 m² per inhabitant, which is very low compared to other European Member States (see also Tab. 2).

Reduction of urban sprawl. Uncontrolled spread of sealing in urban areas is limited with the Spatial Planning Act and the National Spatial Order. Urban development shall not be realised at the expense of undeveloped green areas. Urban renewal has priority over the expansion of settlements into new undeveloped areas.

Protection of the best agricultural land. In order to preserve sufficient agricultural land for growing food and feed it is necessary to preserve agricultural land. On agricultural land, fertility should be protected. Agricultural land should be used in accordance with its purpose and protected against pollution or other degradation.

Brownfield redevelopment. In order to preserve sufficient agricultural land for growing food and feed it is necessary to preserve agricultural land. On agricultural land, fertility should be protected. Agricultural land should be used in accordance with its purpose and protected against pollution or other degradation.

2.25.3 Conclusions

The system of spatial planning (and other) legislation in Slovenia is basically well-designed. Strategic documents and laws in principle contain strategic objectives and policies. Problems occur in the transfer of these strategic objectives to specific implementation documents, because criteria and indicators for goals are not clearly defined in the regulatory documents. Also, it is causing additional problems that commitments are sometimes not well defined. Another problem regarding the implementation of present spatial policy is that the majority of implementation documents in spatial planning were created in the early eighties at a time of public property. Now, in the time of market economy, these documents are inadequate and an obstacle to effective urban planning.

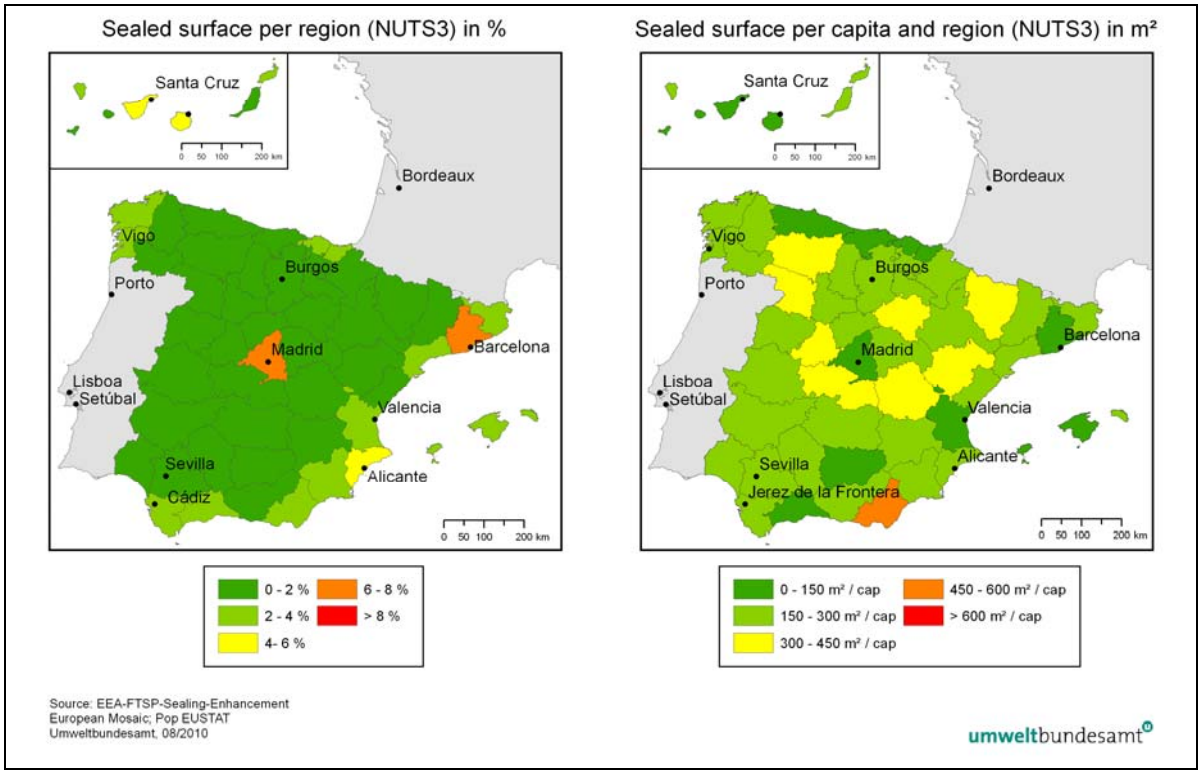
2.26 Spain

Geography. Spain geography is extremely diverse, ranging from the near-deserts of Almeria to the green countryside of the North and the white sandy beaches of the Mediterranean. High plateaus and mountain ranges such as the Pyrenees and the Sierra Nevada dominate mainland Spain and make it the highest European country after Switzerland. Running from these heights are several major rivers such as the Ebro, the Duero, the Tagus and the Guadalquivir. The Balearic Islands lie offshore in the Mediterranean while the autonomous Canary Islands are to be found off the African coast.

Demography. Spain's population has risen rapidly in recent years. Over the period 1990 – 2006, the population increased by 13 %, which is outstanding compared to the EU average of 5 %. Fast population growth resulted in major land use changes. Artificial surfaces increased by 61 % in the same period and put considerable pressure on natural land resources. Urban areas and their related infrastructure were the fastest-growing consumers of land. Today about 80 % of Spain's population live in urban areas.

2.26.1 Land take and sealing

The shares of artificial surface and soil sealing are still very low compared to EU average values of 2 % and 1.3 % respectively[76]. Increasing land take and soil sealing are concentrated in several hot spot areas, among them the agglomerations of Madrid and Leon and all coastal regions.



76 In 2006 EU average shares for artificial surfaces is at 4.4 % and for sealed surfaces at 2.3 %.

Fig. 60 Spain: Soil sealing per region in 2006
Source: EEA, EUROSTAT

In 2008 the Ministry of Housing published the report "*Changes in Spain's landuse and implications to sustainable development*[77]", which provided the first detailed analysis on alarming land use trends and their negative impacts. Key issues were above all

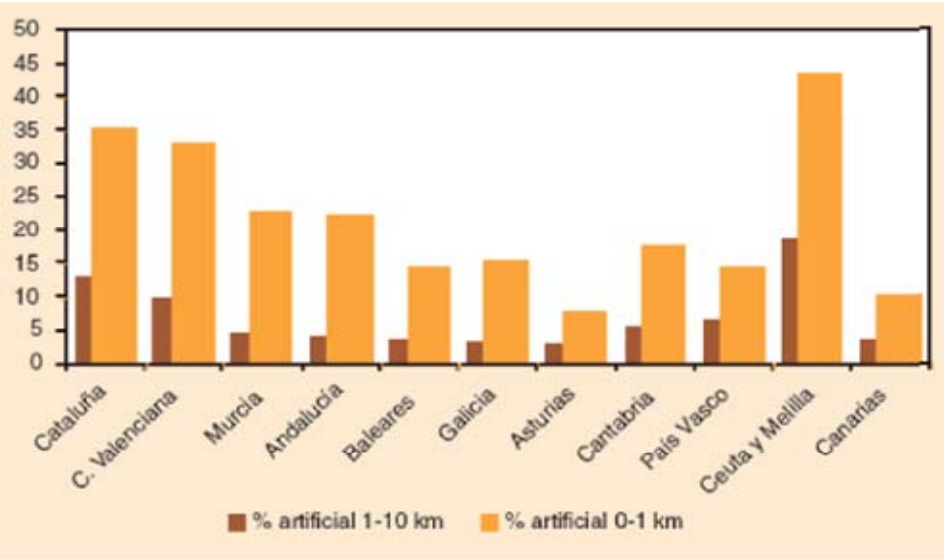
- an accentuated upsurge in the creation of artificial environments both in the interior and coastline regions with major and irreversible consequences,
- a marked decline in woodland eco-systems affecting both their structuring and make-up due to poor management, this leading to an increase in scrubland and fire risks,
- a growth in irrigation often in areas of scant hydraulic resources and a drying up of natural 'wet-zones' coupled with an increase in artificial 'sheet-water' installations [93].

Montoring. Spain does not dispose of a specific national monitoring system for land take or sealing. However, CORINE land cover data are extensively used in several official publications and are the basis for the derivation of land take indicators. The "*increase of artificial area*" is an official sustainability indicator and since 2005 published in the annual sustainability report of the Spanish Survey for Sustainability[78]. The assessments refer to clearly negative trends and refer to the fact that first policy measures to reach trend reversal were implemented. Furthermore, a new indicator with regard to monitoring the quality of life in cities was recently introduced. The indicator refers to "green urban areas per capita" and recommends a minimum of 10 to 15m² public green per inhabitant. The assessment concludes that in cities with more than 100,000 inhabitants the recommended green space was in most cases not available [94], [95].

Coastal regions. Spain's coast lines are definitely most affected by fast growing land take (see following chapter); 45 % of Spain's population live in coastal municipalities which account for just 7 % of the territory. In the autonomous regions of Catalunia, Valencia, Murcia, Ceuta y Melilla and Andalucia the share of artificial surface within the first kilometre from the shoreline is generally above 20 % (see also Fig. 61).

77 Original title: Cambios de ocupación del suelo en España: implicaciones para la sostenibilidad"
78 Observatorio de la Sostenibilidad en España

Spain: Share of artificial surface in coastal areas



Source: Observatorio de la Sostenibilidad en España (Spanish Survey for Sustainability), 2007

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Fig. 61 Spain: Percentage of artificial surface along the coast.
Source: Spanish Survey for Sustainability [96], [97]

Housing trends. Spain experienced a remarkable housing construction boom with regard to private housing combined with an outstanding increase of prices concerning private property. Between 1995 and 2006, the average prices for private housing increased by 170%. Since 1950 the housing stock tripled, whereas the number of households only doubled. Since 2001 more than 500.000 dwellings were built each year, of which about 40 % remain uninhabited or underused. The latter are either second homes or so called “investment homes”, which in many cases remain uninhabited and are neither sold nor rented [97].

2.26.2 Policies of interest

Spatial Planning. Spatial planning is the responsibility of the 17 Regions (Autonomous Communities) and each region has therefore its own detailed planning legislation. The central document is the *Planning Act*[79], which is continuously revised. The latest version from 2007 refers to the need for sustainable urban development, minimising green field development, encouraging brown field development, and the advantages of compact rather than disperse and diffuse urban patterns. The Planning Act defines the general principles of spatial planning, the actual implementation is under the responsibility of the Autonomous Communities.

The most powerful documents for spatial planning are the Territorial General Plans (PTG, Plan Territorial general) of the 17 Autonomous Communities, which are being continually revised. Awareness of massive land use pressures in particular in the coastal regions is more and more considered in these documents. To give an example, the recent planning law

79 Ley 8/2007 de Suelo

of Catalonia requires the protection of natural, agricultural and non-building areas, the reduction of land take, limitation of second home acquisition, new developments to be compact and continuous (and not scattered) [99].

Protection of coasts. Protection of Spain's coasts is the constitutional duty of both national and regional government. The principal piece of legislation in this regard is Law 22/1988, of 28 July, on Coasts. Land cover in coastal areas is governed by the Coasts Law, which defines two protected areas: a 100-metre-wide strip in which all construction is prohibited and a 500-metre-wide area of influence within which building is tightly controlled.

Spain is currently developing a *Strategy for Sustainable Development in Costal Areas*[80], consisting of four phases. The first one is currently most advanced and includes the assessment of the actual state of the coastal environment and the proposition of measures to conserve the natural resources. In the initial phase the Strategy focuses on the Mediterranean coast but shall be expanded to the Atlantic areas as well [96]. A first measure within the Strategy is the demarcation of publicly owned shore line with the objective to establish official boundaries, guarantee public access and use, regulate rational use of its assets and ensure appropriate coastal water quality. By June 2009, 87.2% of Spain's approximately 10,000 kilometres of publicly owned shoreline had been demarcated.

Coast protection and in particular the bans for new developments are taken seriously by the Spanish authorities. Breaches of this ban and the requirement to demolish buildings which were built within the protected belt are regularly reported in the Spanish press. In the case of Tenerife several illegally built dwellings had to be removed[81].

Brownfield redevelopment. In 2008 the *Royal Decree on Housing an Rehabilitation*[82] was enforced, with the aim to regulate affordable housing and to fund urban renovation measures for run down areas. Among others the decree regulates government grants, which support the rehabilitation of historic areas, city centres and rural areas, measures for demolition and replacement of buildings in rundown areas.

2.26.3 Best practice

Neighbourhood renewal in Catalonia. In 2004 the Catalonian government published the *Urban District Law*[83] (Ley de barris) which focuses on the improvement of run down quarters. The law was complemented with a fund that provides financial support for the rehabilitation of derelict urban areas, the *Programme for Urban Areas with Special Needs*[84]. The fund received co-financing from the European Regional Development Funds and was stocked with 25 million Euros. By February 2010 the number of approved rehabilitation projects amounted to 115 at a total volume of 170 million Euro (see Fig. 62).

80 Estrategia para la Sostenibilidad de la Costa
81 http://expediatenerifeproperty.wordpress.com/2010/02/23/tenerife-and-the-spanish-coastal-protection-law/
82 Real Decreto 2066/2008, de 12 de diciembre, por el que se regula el Plan Estatal de Vivienda y Rehabilitación 2009-2012.
83 Llei 2/2004, de millora de barris i àrees urbanes, Generalitat de Catalunya
84 Programa de barris I àrees urbanes d'atenció

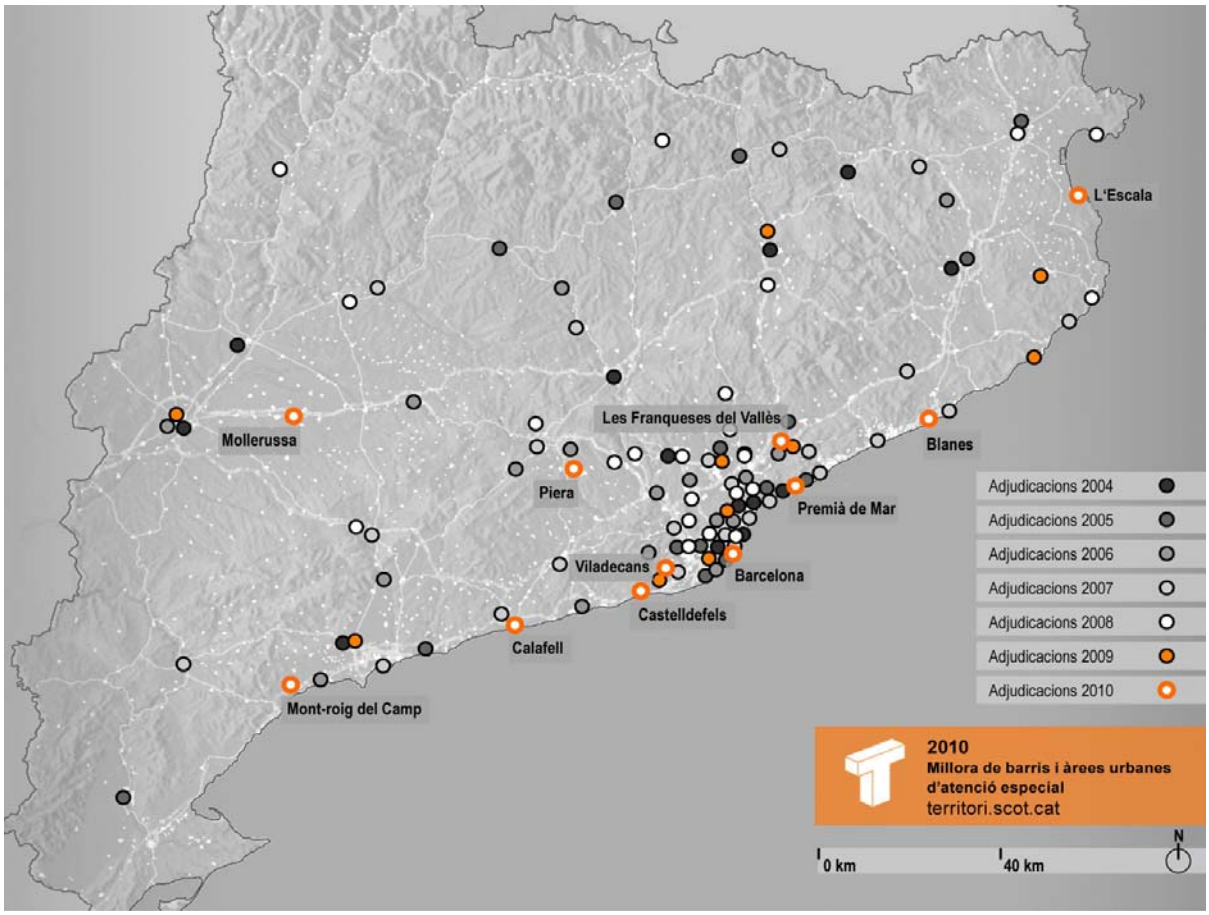


Fig. 62 Urban rehabilitation projects in Catalonia
Source: http://territori.scot.cat/

2.26.4 Conclusions

In comparison with other EU Member States the share of artificial surfaces and sealed soils is still very low. Negative impacts from urban sprawl and soil sealing are limited to a few hot spot areas, namely the large urban agglomerations and the coastal areas. However, in these areas the soil loss and resulting negative impacts are considerable, resulting in erosion, increase of air emissions from traffic, loss of biodiversity and many others.

Awareness of the negative effects of urban sprawl and growing land take is increasing and first measures already initiated. Among them the protection of coastal areas from further land take, the strengthening of brownfield redevelopment, and the regulation of the real estate market.

2.27 Sweden (short country profile)

Geography. Sweden is the third largest EU Member State with a territory of 450,295 km^2. Sweden's topography consists of high mountains in the northwest, bounded on the east by a plateau that slopes down to lowlands and plains in the east and south. Many rivers flow southeast from the mountains to the Gulf of Bothnia, providing abundant waterpower. The principal natural resources are the forests, which cover about two-thirds of the country. One tenth of the country is covered by water courses, in total 95,700 lakes. Most of Sweden's cultivated land is in the South. Sweden has large deposits of iron and other minerals and an estimated 15 percent of the world's uranium deposits.

Demography. Sweden's population is growing constantly and amounts today to 9.3 million inhabitants in 2009. Most regions are very sparsely populated with less than 20 persons per km². The South of the country between the Öresund region and Stockholm is the most populated area. About 85% of the population live in urban areas. Sweden has three metropolitan areas consisting of the areas surrounding the three largest cities, Stockholm, Gothenburg and Malmö.

2.27.1 Land take and sealing

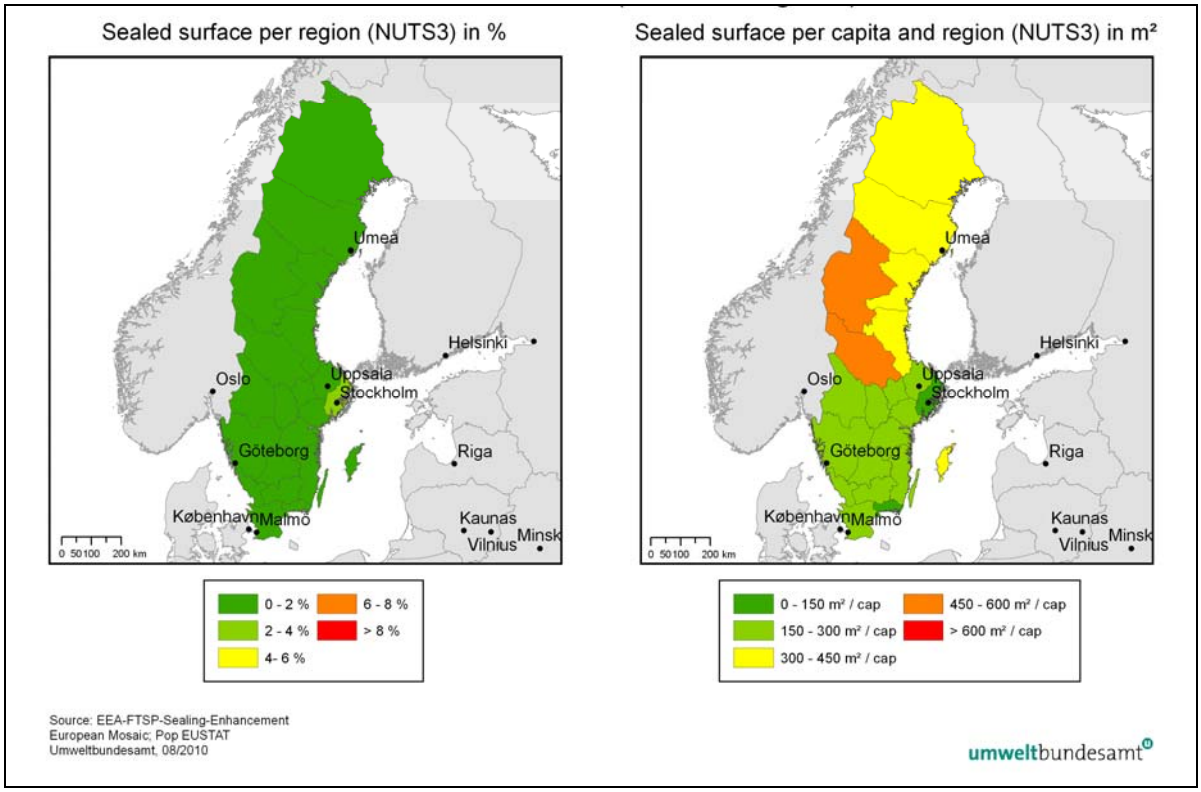


Fig. 63 Sweden: Soil sealing per region in 2006
Source: EEA, EUROSTAT

The shares of artificial surface and sealed surface are among the lowest within EU 27 with 1.4 % and 0.4 % respectively[85]. Land take between 2000 and 2006 was insignificant. The

85 EU average for artificial surface: 4.4 %, for sealed surfaces: 2.2 %

average land use intensity is very low with almost 700 m² per inhabitant. This is due to the fact that the country is very large and in most areas extremely sparsely populated

2.27.2 Policies of interest

Sweden's environment policy is based on *16 Environmental Quality Objectives* for different areas, adopted by the Swedish Parliament in 1999 and in 2005. Two quality objectives make specific reference to soil sealing [101]:

- Environmental quality objective 15 refers to achieving “A Good Built Environment” and demands among many other requirements that soil sealing shall not be expanded in densely populated areas and that nature and “water areas” shall be preserved until 2020.
- Environmental quality objective 9 refers to maintaining “Good Quality Groundwater” requires that soil sealing shall not have a negative impact on ground water before 2015.

The Environmental Quality Objectives are being monitored and assessed. Results are being published on the Environmental Objectives Portal (*Miljömål*). With regard to quality objective 15, achieving “A Good Built Environment”, the assessment concludes that the objective will not be reached until 2020 but this failure is not related to land take and sealing but mainly to a lack of noise reduction measures and lack of technical measures to improve the indoor climate of specific buildings [102].

Sustainable development of cities is an important issue in Sweden. In the field of planning and urban development the *Boverket* (the National Board of Housing, Building and Planning) is responsible for ensuring that ecological, economic, cultural and social aspects are taken into account in planning. Boverket is also responsible for the Environmental Quality Objective 15 ”A Good Built Environment”, which refers to soil sealing and conservation of green fields and water areas in city areas[86] [103].

2.27.3 Best practice

A remarkable urban planning project is the *Västra hamnen* in Malmö. A new modern district with 1,000 flats is currently being developed on derelict harbour premises. The project is a showcase for urban living with the lowest possible carbon foot print [104].

The Governments of Denmark and Sweden have a joint aim of developing the Øresund Region into one of the cleanest urban regions in Europe (see also Denmark chapter page 69). Key objectives are

- to counteract urban sprawl and the depopulation of city centres, to protect open stretches of landscape and undeveloped areas in coastal areas and to develop the green structure between and around cities and towns;
- to attempt to transform urban areas and increase density by reusing derelict urban land instead of building on green fields; and
- to give priority to urban development in locations with good access to public transport.

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86 A Good Built Environment: http://miljomal.se/Environmental-Objectives-Portal/15-A-Good-Built-Environment/

2.27.4 Conclusions

Land take and soil sealing are in generally insignificant and affect only very few regions. In densely populated areas land take and soil sealing are regulated at the level of city planning. Specific emphasis is put on reducing environmental impacts in urban areas.

2.28 United Kingdom

Geography. The total area of the United Kingdom is approximately 245,000 km² including the island of Great Britain, Northern Ireland and smaller islands. England is the largest country of the United Kingdom representing 53 % of the total area and Scotland 32 %, Wales and Northern Ireland 8 % and 6 % respectively.

The Geography of England consists of lowland terrain, with mountainous terrain north-west of the Tees-Exe line including the Cumbrian Mountains of the Lake District, the Pennines and limestone hills of the Peak District, Exmoor and Dartmoor. The Geography of Scotland is distinguished by the Highland Boundary Fault which separates the two distinctively different regions of the Highlands to the north and west and the lowlands to the south and east. Wales is mostly mountainous, though south Wales is less mountainous than north and mid Wales. The Geography of Ireland includes the Mourne Mountains as well as Lough Neagh, at 388 km², the largest body of water in the UK and Ireland.

About 46% of the land is used as permanent pastures, 25% are arable land, 10% forests and woodland and about 19% are other land uses.

Demography. The UK has about 61.8 million inhabitants, of which 84 % live in England. Between 1990 and 2006 population of the UK was slightly faster growing than the EU average. With 250 persons per km² the United Kingdom has one of the highest population densities in the world, with a particularly high population density in England amounting to 397 inhabitants per km². 51 % of the UK's population live in large cities with more than 50,000 inhabitants. The UK's largest cities are London and Birmingham with 7.6 and 1 million inhabitants.

2.28.1 Land take and sealing

Of the four countries England, Wales, Scotland and Northern Ireland, the first one is most densely populated and also most heavily affected by urban sprawl and sol sealing. In particular the South East of England has the greatest density of development. Urban sprawl in particular has been recognised as a source of concern for many years with the first policy to address this adopted as early as 1935.

Comparison with other EU Member States[87]. The UK has one of the lowest soil sealing indices in the EU, with only 156 m^2 per inhabitant due to intensive (re)use of brownfields. Between 1990 and 2000 the average annual land take was the lowest observed with less than 1 m² per capita and year.

87 CORINE Land Cover data for the year 2006 were not available for this assessment

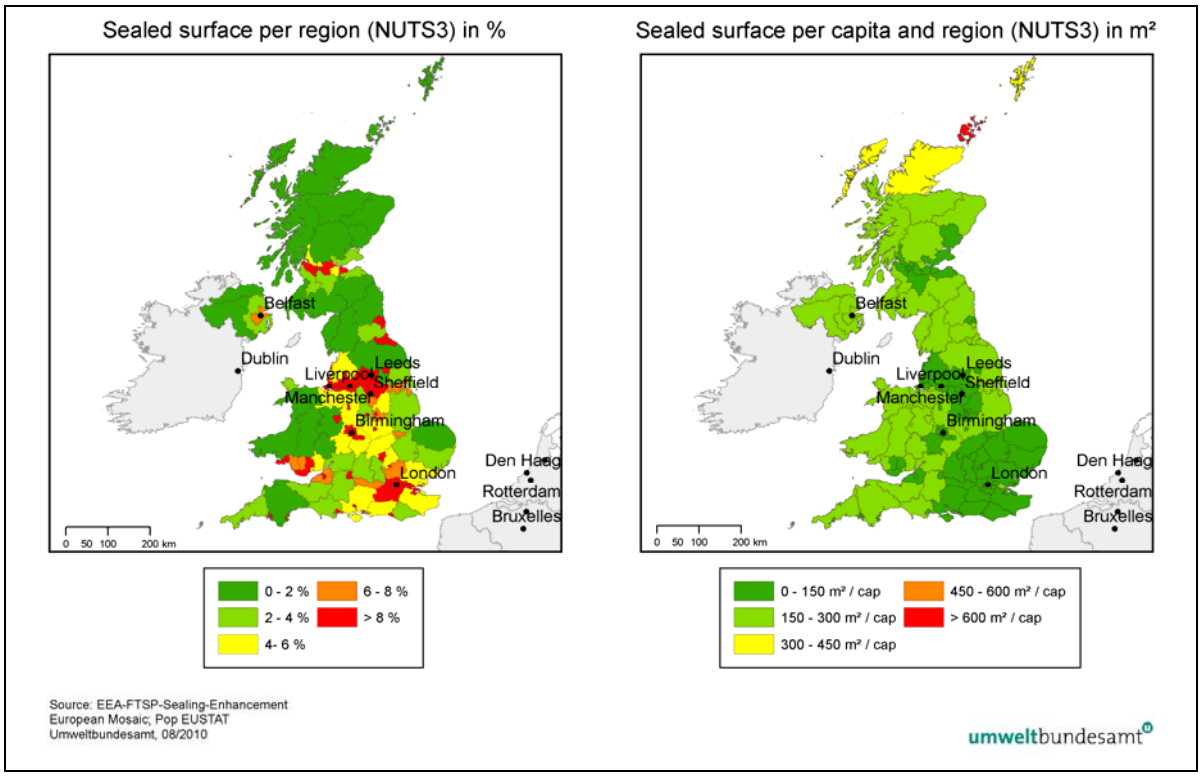


Fig. 64 United Kingdom: Soil sealing per region in 2006
Source: EEA, EUROSTAT

In 2001 nearly 80 per cent of the UK population lived in urban areas, despite the fact that these made up 9 % of the total land area. The UK's ten largest urban areas are home to a third of the population – just over 19 million people. The Greater London Urban Area had the highest population density (5,100 people per square kilometre) in 2001, as well as the largest area and population. It was 2.7 times larger and its population 3.6 times greater than the West Midlands Urban Area – its closest neighbour in terms of population and area size. Between the 1991 and 2001 censuses the growth in the area of Greater London was the most significant of all urban areas, expanding by 8 % largely as a consequence of population growth.

While urban areas are expanding in the UK, it could be argued that this expansion has perhaps been tempered by a focus on building on previously development land, rather than greenfield sites. In the case of England, it was estimated that 77 % of new dwellings were built on previously developed land, at a density of 44 dwellings per hectare (see Fig. 65). This means that England's urban areas are expanding slowly and they are also becoming more dense in terms of their development [105].

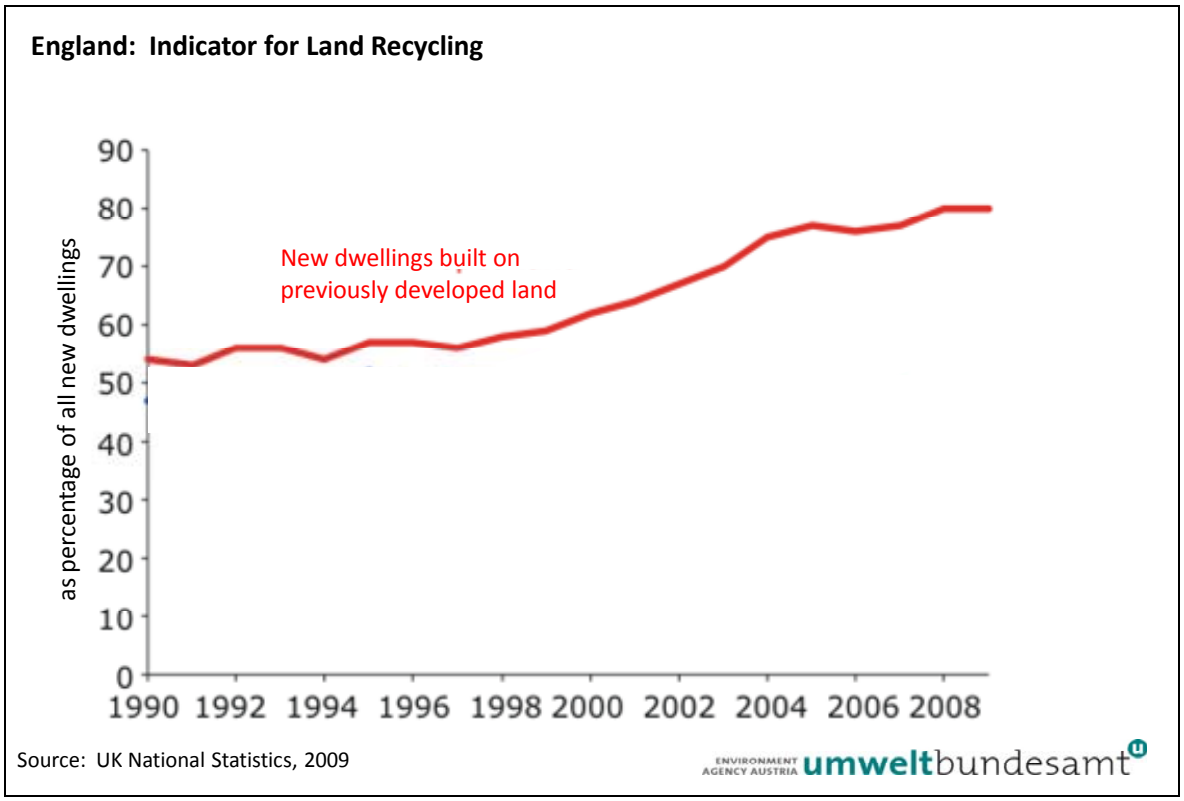


Fig. 65 England: New dwellings built on previously developed land
Source: UK National Statistics, 2009 [105]

2.28.2 Policies of Interest

In terms of the protection of soils the UK has few directly targeted laws or policies. In 2009 the government adopted its first ever Soil Strategy for England, setting out the strategic direction for addressing soil issues. The focus within the strategy on soil sealing is limited. While this is raised as an issue it is commented that 'the planning system provides a framework within which consideration can be given to the environmental, economic and social costs and benefits of the development and use of land. The planning system is also increasingly recognising the importance of mitigating the impacts of soil sealing, particularly in relation to urban drainage and maintaining green infrastructure'. It is therefore to the different elements of the planning system and planning law that it is necessary to look in order to understand UK policy approaches to dealing with urbanisation. In addition there has been the recent evolution of grass roots projects aimed at limiting to the impacts of soil sealing, primarily is response to localised urban flooding or concerns regarding future impact on waste availability.

Reducing soil sealing and urban sprawl. It should be noted that in the UK planning is an issue that is devolved largely to the administrations in Scotland, Wales and Northern Ireland. While the approach across the UK is largely consistent as a consequence the exact policy numbers and certain approaches may vary. The most significant discussed here. These largely focus on England given that the greatest intensity of urban development exists in SE England.

Across the UK the Town and Country Planning Act (and its equivalents) sets out the basis for planning decisions. This is supported by a series of guidance documents applicable to the different countries. For the UK the overall approach to land use planning is set out in Plan-

ning Policy Statement 1. This sets out the approach to the use of Development Plans at the local authority level as the key tool for delivering land use decision-making. It states that 'Development plan policies should take account of environmental issues such as: the conservation of soil quality [106]. The only other direct reference of relevance initiatives are to soil sealing is that PPS 1 also states that 'Regional planning authorities and local authorities should promote the use of sustainable drainage systems in the management of run-off'.

The UK has adopted strong policies that aggressively promote the construction of new builds on previously developed land as oppose to greenfield sites. This consists of efforts to promote brownfield development, but also to provide a greenbelt around urban areas to limit sprawl, restrictive planning requirements in areas deemed as countryside and systems designed to protect high value agricultural land.

Green Belt Policy. As highlighted in the introduction the UK has a legacy of concern over urban sprawl and the desire to preserve 'England's green and pleasant land'. As early as 1935 a Greenbelt was established around Greater London. In 1955 the Greenbelt policy was extended to areas other than London. According to Planning Policy Guidance No 2, adopted in 1995 and amended in 2001, specifying current rules on Greenbelt, Greenbelt covers 12 % of England. There are 14 separate Greenbelts with the largest amounting to 486,000 hectares around London [107]. According to PPG 2 there are five purposes of including land in Green Belts: 1/ to check the unrestricted sprawl of large built-up areas; 2/ to prevent neighbouring towns from merging into one another; 3/ to assist in safeguarding the countryside from encroachment; 4/ to preserve the setting and special character of historic towns; and 5/ to assist in urban regeneration, by encouraging the recycling of derelict and other urban land.

Overall objectives of the Green Belt policy are to create recreational areas with attractive landscapes and in particular to improve the standards of life around damaged and derelict land around towns.

Development is highly restricted within Green Belt, with the protection of this land fiercely upheld both by local authorities and residents. There is a presumption against development in these areas with construction of new buildings only permitted for the following purposes: 1/ agriculture and forestry; 2/ essential facilities for outdoor sport and outdoor recreation, for cemeteries, and for other uses of land which preserve the openness of the Green Belt and which do not conflict with the purposes of including land in it; 3/ limited extension, alteration or replacement of existing dwellings; and 4/ limited infilling in existing villages.

Reuse of brownfield land. Planning Policy Statement 3, for England sets out the rules to be abided by when considering the development of housing [108]. This importantly includes specifically the UK approach to focusing housing development on previously developed land. Within PPS 3 previously developed or brownfield sites are defined as: *'land is that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure'*. The definition includes defence buildings, but excludes land that is or has been occupied by agricultural or forestry buildings, quarries and land fills, parks and heritage sites.

Importantly PPS 3 sets a specific 'national annual target' stating that at least 60% of new housing should be provided on previously developed land. It goes on to state that when identifying previously-developed land for housing development, Local Planning Authorities and Regional Planning Bodies will, in particular, need to consider sustainability issues as some sites will not necessarily be suitable for housing.

Not only is the target specified at the national level, but it is required that Regional Spatial

Strategies specify their own targets (intended to help deliver the meeting of the national target, bearing in mind the availability of land and demand in the region) and that this be translated to the local level as well. At the local level, Local Development Documents should include a local previously developed land target, a trajectory and strategies for bringing previously-developed land into housing use (as local authorities are unlikely to own or have direct powers over any given piece of land).

The promotion of brownfield development has been particularly successful in the UK and as early as 2000 the 60% target had been reached. However, given the diversity of urban areas in the UK and the difference in historic often-industrial legacy in different regions the proportions of development on brownfield land vary significantly across the UK. For example in London 90% of houses are built on previously developed land, while in the South West of England and East Midlands less that 40 % are delivered [109].

Protection of agricultural soils. Across the UK a system of classifying agricultural land is in operation, intended to identify the best quality land and soils and protect these. In practice the competency for overseeing the classification of land is devolved with, for example, Natural England acting as Regulator in England. Guidance from Natural England [110] divides land into five Grades (1, 2, 3, 3a, 3b). The best and most versatile land is defined as Grades 1, 2 and 3a by policy guidance (see PPS7). This is the land which is most flexible, productive and efficient in response to inputs and which can best deliver future crops for food and non food uses such as biomass, fibres and pharmaceuticals. Current estimates are that Grades 1 and 2 together form about 21% of all farmland in England; Subgrade 3a contains a similar amount. The Classification is based on the long term physical limitations of land for agricultural use. Factors affecting the grade are climate, site and soil characteristics, and the important interactions between them. In theory development should avoid the highest grades of agricultural land.

The Scottish Government also has a policy on the protection of agricultural land, as set out in their SDD Circular 18/87 (as amended by SOEnD Circular 25/1994). This states that when considering the allocation of land for development and in deciding applications for planning permission affecting agricultural land, the agricultural implications must be considered together with the environmental, cultural and socioeconomic aspects. In particular, prime quality land should normally be protected against permanent development or irreversible damage. However, in practice, very few planning applications are refused with agricultural land quality cited as a reason for refusal. Moreover, as the vast majority of land in Scotland is not defined as of prime agricultural quality, there is no protection for functionality of soils over most of Scotland.

Flood risk prevention. Increasingly in the UK there are concerns about the drainage impacts associated with urban development. In particular flooding events, for example in 2007, have raised concerns about inappropriate intensification of sealing and the consequences for flood risk. In England Planning Policy Statement 25 on Development and Flood Risk [111] specifically advocates sustainable drainage principles for new developments [112].

While the policy system appears to include requirements intended to limit the impact of new development on drainage and flood risk several questions remain. Firstly, questions have been raised about the effectiveness of these policies in delivering sustainable drainage systems. Secondly, the high level guidance focuses on extensive new developments, but increasingly there is a problem associated with the intensity of urban development for example people independently paving over their front gardens leading to flooding problems.

There are several innovative approaches that have been adopted to dealing with this issue

including funding schemes to improve urban drainage, demonstration projects and local community action to address the question of individual's impact on local drainage.

2.28.3 Best Practice

A broad range of initiatives are currently being launched to promote the use of Sustainable Urban Drainage Systems (SUD), including a funding programme, research on permeable material and their cost benefit profile, dissemination of practical guidance for all relevant stakeholders, show case projects, and public participation projects. SUD describes a range of techniques for managing the flow of water run-off from a site by treating it on site and so reducing the loading on conventional piped drainage systems

The idea behind SUDS is to try replicate natural systems that use cost effective solutions with low environmental impact to drain away dirty and surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into the environment, such as into water courses. SUDS use the following techniques: source control, permeable paving such as pervious concrete, storm water detention, storm water infiltration, evapo-transpiration (e.g. from a Green roof)

- Funding better drainage in London. The Department of Environment Food and Rural Affairs have allocated 3.8 mio. € funding for surface water management plans in London. As part of the work, a data platform to share information and a green-roof fund will be set up.
- Demonstration of Good Practice. A show case project for the full range of possible Sustainable Water Management Techniques within residential developments was realized in Lamb Dove (see also Best Practice, chapter 3).
  The construction industry research and information association (CIRIA) runs a website dedicated to promoting and offering support on sustainable urban drainage solutions [113]
- Research. Several remarkable research projects with regard to SUDs, their costs and benefits and their barriers to implementation were carried out. To give two examples:
  1/ A cost benefit analysis of permeable and impermeable surfaces [114] carried out by CIRIA also including a survey on acceptance, knowledge and availability of SUD techniques in the UK (see also chapter 3, Research).
  2/ An impact assessment of permeable surfaces which addresses the specific question why permeable surfaces require government intervention. [115]
- Awareness and Public Participation. To convince citizens of the benefits of green gardens with permeable surfaces is the key objective of the Ealing Front Garden Project [see also Best Practice, chapter 3].

2.28.4 Conclusions

The UK has a long history of attempting to control urban development, given its industrialised past. Importantly it has coupled policies aimed at promoting the use of brownfield sites with highly restrictive policies for development in the countryside and also the imposition of greenbelts, essentially tightly restricting the extent of urban development.

England has the strongest policy with regard to limiting urban sprawl. As a consequence England has successfully met its target of delivering 60 % of housing on brownfield sites. However, the intensity of urban development has increased in England. This has lead to problems with localised flooding associated with sealing for example of front gardens. This

has lead to an increased interest in the consideration of sustainable drainage solutions as illustrated in particular by interest in drainage issues in London and specifically Ealing. England's sealing policies are all indirect. The direct interest in preserving the functions of the soils is limited, it is the consequences of sealing i.e. sprawl and flooding that the UK is most keen to address.

2.29 Summary

Soil sealing is caused by several driving forces and creates a variety of negative but also beneficial effects, both of which affect the 27 EU Member States differently.

Tab. 6 provides an overview how Member States are actually affected by the pressures that lead to increased soil sealing, the actual state of sealing within their territory (in decreasing order), whether or not responses at the policy level have already been initiated, and if a policy target exist or not.

Since Member States are differently affected by land take and soil sealing their responses towards the issue are also subject to great variations. While ten Member States, mainly those with high or very high sealing rates, have already implemented measures to reduce land take, some two thirds of the EU have either not yet addressed the problem or just started to cope with the challenge.

The column **"Pressures"** refers to unsustainable trends between 2000 and 2006 and distinguishes between three categories; *Green colour* stands for insignificant land use pressures; i.e. insignificant land take in relation to population growth; *Yellow colour* means moderate land use pressures, like moderate land take in relation to population growth, and *Red Colour*, refers to high land use pressures, in particular to land take increasing faster than population growth. The definition of thresholds is based on the principle of decoupling population growth and growth of artificial surfaces and is visualised in Fig. 6.

- Unsustainable land use trends can be observed in, Cyprus, Denmark, the Netherlands and Portugal where land take is growing considerable faster than population growth. Furthermore several new Member States are also affected by unsustainable land use trends due to continuing land take and at the same shrinking populations.
- Positive land use trends can be observed in Austria, Belgium, Finland, France, Luxembourg, Italy, Malta, Slovenia, and Sweden where land take is either insignificant or lower than population growth.

The column **"State"** refers to the share of sealed surfaces in decreasing order; *Green colour* stands for a low sealing rate with less than 1.6 %, *Yellow colour* refers to a moderate sealing rate ranging between 1.6 % and 3 %; and *Red Colour* indicates high sealing rates with more than 3 %. For the definition of thresholds the principle of arithmetic average was used.

- The highest sealing rates can be observed in Malta with 13 %, the Netherlands with 8 %, Belgium with 7.4 %, Germany and Luxembourg each with around 5 %, and Cyprus and Denmark, each with 3.6 %.
- The lowest sealing rates can be observed in Ireland and Romania (each with 1.6 %), Spain (1.4 %). Greece (1.3 %), Latvia (1.1 %), Estonia, Finland and Sweden (each with less than 1 %).

The last column refers to the existence of policy targets with regard to reducing land take.

- Policy targets for land take. Quantitative limits for annual land take exist only in six Member States: Austria, Belgium (Flanders), Germany, Luxembourg, the Netherlands, and the United Kingdom. In all cases the limits are indicative and are used as monitoring tools.

The column **"Responses"** refers to the intensity of already implemented measures. *Green colour* indicates that several measures to reduce land take have been implemented, *Yellow colour* refers to the fact that first measures to reduce land take were implemented, and *Red Colour* that no specific measures to reduce land take exist. The following most promising measures and policies to mitigate land take and soil sealing were identified:

- Sustainable spatial planning. The majority of the EU Member States have established the principle of sustainable development in their key spatial planning regulations, referring to economic use of soil resources and avoidance of unnecessary urban sprawl. However, the existence of relevant regulations does not give any insight on the effectiveness of implemented measures.
- Improvement of quality of life in large urban centres. Run down city quarters with decreasing population can be found in most European metropolitan areas. The phenomenon of people moving to urban fringes and leaving behind city centres with decreasing population is widespread. As a result distances between new dwellings and city centres are growing continually and car dependency is increasing. Several urban renewal programmes have been launched recently with the objective to attract new residents and create new jobs in central urban areas of decline. Best practice examples in this respect are (1) the urban renewal programmes of *Porto* and *Lisbon* and the neighbourhood renewal programme in *Catalonia* both of which are supported by the European Regional Development Funds, (2) the *Västra hamnen* project in Malmö which is built on derelict harbour premises providing 1,000 new dwellings with the lowest possible environmental impact, (3) the *Erdberger Mais* development in Vienna which is realised on five inner urban brownfield areas, providing housing for 6,000 new inhabitants and 40,000 work places, (4) the *Randstad* programme in the Netherlands which puts special emphasis on improving the attractiveness of inner urban areas in the metropolitan agglomeration of Amsterdam, Rotterdam, and Den Haag.
- Brownfield redevelopment. Initial or supportive funding to encourage new infrastructure developments on brownfield sites exists in several Member States and is usually coordinated by designated brownfield organisations. Brownfield redevelopment projects are mostly realised in the form of private public partnerships. (1) The *English Partnerships* is probably the most experienced public land developer in the European Union and provides funding for social housing developments on derelict areas. (2) France disposes of a network of more than 20 public land development agencies, which among other activities develop brownfield land for social housing. (3) The land development agencies *Czech Invest* and *Invest in Silesia* are in charge of developing major industrial brownfields for new industrial investors. (4) In Flanders specific contracts (brownfield covenants) are negotiated between the government and private investors to promote brownfield redevelopment.
- Consideration of soil quality along planning processes. The integration of soil protection and hence protection of soil functions in spatial planning is relatively new and is a result of a general commitment to sustainable spatial planning. At the international level the Interreg project TUSEC-IP established criteria how to respect soil functions in spatial planning. The project results are increasingly influencing spatial planning standards, as this is the case in Germany, Northern Italy and Austria. Indicative guidelines to respect soil functions in spatial planning procedures exist in all German Federal States, in two Austrian Provinces, and in the autonomous province of Bolzano. Awareness of soil functions and how to respect them in spatial planning is increasingly growing.

Tab. 6 Soil sealing in EU 27: pressures, state and responses in the EU Member States.
Source: Umweltbundesamt, 2010

Country	Pressures (unsustainable trends 2000 - 2006)	State (sealing)	Responses	Policy Target
Malta	insignificant land take despite rapid population growth	13 % high	no specific measures in place	N
Netherlands	artificial surface is growing faster than population	8.1 % high	several measures implemented	Y
Belgium	annual land take is decreasing despite growing population	7.4 % High	several measures implemented	Y (Flanders)
Germany	land take and population are stagnating	5.1 % high	several measures implemented	Y
Luxembourg	annual land take is decreasing, steady population growth	4.9 % high	several measures implemented	Y
Cyprus	land take is growing faster than population	3.6 % high	no specific measures in place	N
Denmark	land take is growing faster than population	3.6 % high	several measures implemented	N
United Kingdom	annual land take is decreasing despite growing population	3.4 % high	several measures implemented	Y
Hungary	land take is growing despite shrinking population	3.2% high	no specific measures in place	N
Czech Republic	land take is slowing down, population is stagnating	3.2 % high	several measures implemented	N
Portugal	land take is growing faster than population	3.1 % high	first measures initiated	N
France	annual land take is decreasing despite growing population	2.8 % medium	first measures initiated	Y
Italy	annual land take is decreasing despite growing population	2.8 % medium	first measures initiated	N
Poland	land take is slowing down, population is shrinking	2.4 % medium	first measures initiated	N
Slovakia	land take is slowing down, population is stagnating	2.4 % medium	several measures implemented	N
Lithuania	land take is growing despite shrinking population	2.2 % medium	no specific measures in place	N
Austria	annual land take is decreasing, steady population growth	1.9 % medium	several measures implemented	Y
Bulgaria	land take is growing despite shrinking population	1.8 medium	no specific measures in place	N
Slovenia	insignificant land take, population is stagnating	1.8 % medium	several measures implemented	N
Ireland	land take is slowing down, steady population growth	1.6 % low	first measures initiated	N
Romania	land take is growing despite shrinking population	1.6 % low	no specific measures in place	N
Spain	land take is growing faster than population growth	1.4 % low	first measures initiated	N
Greece	data gap	1.3 % low	no specific measures in place	N
Latvia	land take is growing despite shrinking population	1.1 % low	no specific measures in place	N
Estonia	land take is growing despite shrinking population	0.9 % low	no specific measures in place	N
Finland	insignificant land take despite growing population	0.6 % low	first measures initiated	N
Sweden	insignificant land take despite growing population	0.4 % low	several measures implemented	N

- Protection of agricultural soils and landscapes. Most Member States have established specific policies to avoid further land take and sealing on their best agricultural soils and most valuable landscapes, as this is the case (1) in Spain where building activities within the first 500 metres from the sea are strictly controlled, (2) in France and the Netherlands where designated “green and blue” landscapes are protected from infrastructure developments, (3) in the Czech Republic and Slovakia where the conversion of top agricultural soils requires a fee.

3 TECHNICAL MEASURES TO MITIGATE SOIL SEALING

The following section describes two construction methods which have the one property in common; they improve the local water capacity.

- Permeable surfaces
- Green roofs

Permeable surfaces can be considered as a method to reduce soil sealing along construction projects. Green roofs can not necessarily be classified as instruments to reduce soil sealing, however they generate new green space and create an added value to the quality of living in particular in very densely built areas.

3.1 Permeable surfaces

Permeable surfaces reduce soil sealing and increase the water drainage capacity of surfaces. However, permeable surfaces cannot be considered as a soil protection measure, since all techniques require removal of the upper soil layer of at least 30 cm. In some cases the original soil can be replaced to some extent, as in the case of gravel turf.

A variety of construction materials and techniques for permeable surfaces exist, they differ in their properties in particular in their frequency of use, allowable mechanical load, subsurface, environmental benefits, permeability, maintenance and of course in their costs. The current chapter is divided in four subsections:

- The principle of permeable surfaces, in particular in comparison with conventional impermeable surfaces,
- Overview of most common permeable surfaces. A brief description, including their benefits and most common applications.
- Detailed technical description of selected techniques. Three techniques were selected, due to their broad application potential, their low costs and maintenance.
- Legal requirements and incentives. In some European regions and cities financial incentives support the application of permeable surfaces or are even stipulated by the planning legislation. Identified examples are described and explained.
- Best practice. A few examples of exceptional applications are given.

3.1.1 The principle of permeable surfaces

Permeable surfaces aim to increase the water drainage capacity of surfaces and are in many cases a visual improvement to conventional asphalt layers. Key benefits usually are:

- flood prevention
- a relief of the local sewage water system,
- a contribution to the formation of natural groundwater,
- an improvement of the micro climate[88], due to increased water evaporation,

[88] Recent surface temperature surveys from the cities Budapest (Hungary) and Zaragoza (Spain) revealed that temperatures in highly sealed areas can be up to 20 °C higher compared to green shaded surfaces, see also reference [5].

- the use of regional material - in some cases also recycling material (i.e. compost, building rubble),
- in some cases vegetation layers are possible, and
- in most cases a visual improvement.

Permeable surfaces play an important role in flood prevention since they can reduce the velocity and quantity of run-off water. In order to understand the full range of benefits and limitations of permeable surfaces their function is explained and compared to conventional asphalt surfaces (see also Fig. 66).

Conventional impermeable surfaces normally fulfil only one function e.g. prevention of the infiltration of pollutants, namely the support of vehicles and pedestrians. Rainwater flows over the surface to a gully and then to a drainage system. In urban areas this is usually the municipal sewage system. In the event of heavy rainfall sewage systems in urban areas tend to be overloaded.

- Layers. The impermeable layer consists of asphalt or concrete bricks and usually has a depth of up to 15 cm. For heavily trafficked surfaces two layers of asphalt are applied. The subbase consists of compacted loose material with fine particles. The thickness of this layer depends on the use intensity of the surface and ranges between 15 and 30 cm.
- Life time. A conventional asphalt layer is expected to last 20 years, the life time is longer if the use intensity is low.
- Costs. The costs of a conventional asphalt surface depend on the crude oil price and the local personnel costs. In 2010 the crude oil price was at 70 to 90 U$/barrel and the price for conventional asphalt layers amounted to approximately 35 to 40€/m² (without VAT) in Central European countries.
- Maintenance. After 10 years the surface may need “resurfacing”, meaning that an upper layer of about 4 cm is removed and replaced by a new asphalt layer.
- End of life time. Recycling of asphalt is to some extent possible but is very energy intensive.

Permeable surfaces provide support and drainage at the same time. They have to be considered as filter and storage units and cannot exist alone, since they need to be complemented with either a drainage system or an infiltration basin. Only in the case of gravel turf is a “stand alone” solution without drainage system possible. Permeable surfaces allow rainwater to soak through the surface into the underlying sub-base where the water is temporarily stored before it either percolates into the ground or flows to a drainage system. Fig. 66 shows the key differences of the two systems. The following section provides an overview of the most common permeable surfaces, their subsoil layers, recycling options, maintenance and costs.

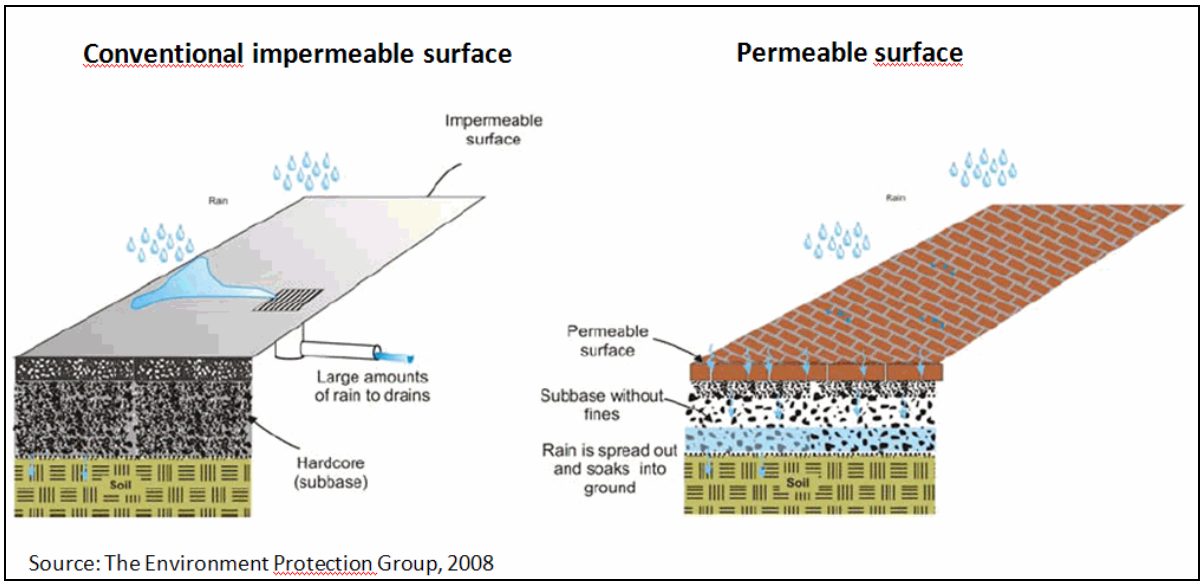


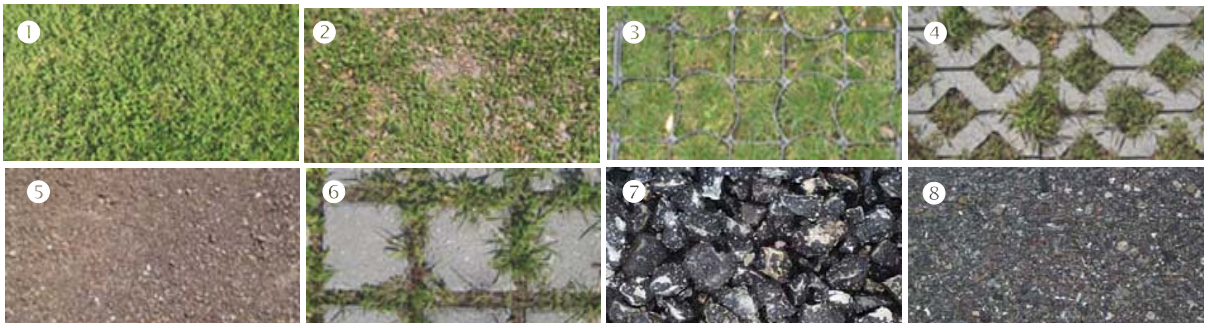
Fig. 66 Difference between impermeable and permeable surface
Sources: The Environment Protection Group [114].

The *water run-off co-efficient* is used to define how much water can actually percolate through the surface. Totally sealed surfaces have a coefficient of 1, meaning that no surface water seeps through the surface. Completely permeable surfaces have a coefficient of zero which means that no surface water is left. The subsequent section provides an overview of the most common surfaces (see also Fig. 67) and includes short technical descriptions for each of them.

3.1.2 Overview of most common permeable surfaces

The current section provides an overview of the most common permeable surfaces. Information on costs is related to conventional impermeable asphalt surfaces and is indicative, because labour costs are highly differential among the EU Member States.

In Fig. 67 the most common surfaces for “artificial” open areas are shown. The surfaces are presented according to their permeability; i.e. the first picture shows conventional lawn which can be considered as 100 % unsealed, pictures 2 to 7 refer to various permeable surfaces, and the last picture shows asphalt, being 100 % sealed.



(1) Lawn, (2) Gravel Turf, (3) Plastic grass grids, (4) Concrete grass grids, (5) Water bound macadam, (6) Permeable pavers, (7) Porous asphalt, (8) Conventional asphalt

Fig. 67 Overview of most common surfaces
Sources: [116], [117], [118]

Tab. 7 Comparison of benefits and limitations of most common permeable surfaces (in relation to asphalt)
Sources: [116], [117], [118]

	pedestrians	parking, small vehicles	parking, medium vehicles	road traffic	Visual appearance	Vegetation possible	High drainage capacity	Regional materials	Improves micro climate	High maintenance	Bad walking comfort	No disabled parking	Sludge accumulation	Dust formation	Unsealed surface	Run-off coefficient	Costs*: Asphalt = 100%
	Application range				Benefits					Limitations							
Lawn, sandy soil					+++	+++	+++	+++	+++			+++	+++		100%	<0.1	< 2 %
Gravel Turf	Y	Y	Y		++	++	++	+++	++	+	+	+			100%	0.1 - 0.3	50 - 60 %
Grass grids (plastic)	Y	Y			++	++	++	+	++	++	++	++	+		90%	0.3 - 0.5	75 %
Grass grids (concrete)	Y	Y	Y	Y	++	++	+	+++	++	++	++	++	+		40%	0.6-0.7	75 - 100 %
Water bound surfaces	Y	Y	Y		+		+	+++		++	+	+	++	++	50%	0.5	50%
Permeable pavers	Y	Y	Y		+		+	+++	+	+					20%	0.5-0.6	100 - 125 %
Porous asphalt	Y	Y	Y	Y			++								0%	0.5 - 0.7	100 - 125 %
Asphalt	Y	Y	Y	Y											0%	1.0	100 %

* Indicative costs in relation to asphalt are provided, in 2010 average costs for conventional asphalt layers amounted to approximately 40 €/m² (without VAT), including construction costs. For each surface type material costs and labour costs were considered.

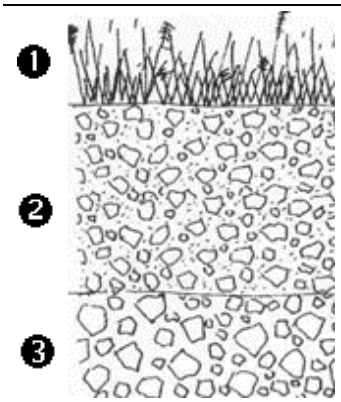
3.1.3 Gravel Turf

Gravel turf looks like conventional lawn and can absorb rain water up to 100 %. Gravel turf is also known as “reinforced grass with gravel” is currently the most promising technique for parking areas and low frequented roads. The building costs are currently less than half compared to conventional asphalt layers and maintenance is very low. However, their construction needs qualified “building competence”. In the past bad practice has led to plugged in surfaces and loss of water drainage capacity. The technique was remarkably improved in recent years, and gravel turf is today a promising ecological surface for public parking areas. Key barriers are currently lack of experience of builders and restrictions from the water authorities, who in many cases demand that rain water of large surfaces is directed to a sewage system.

Left: parking area, Below: gravel turf,
Bottom: normal lawn

Fig. 68 Gravel turf
Source: Green Concrete [119]

Tab. 8 Gravel turf – technical description of layers and building material
Source: [117], [119], [120]



	L = low frequency	M –S = medium to strong frequency
❶	❶ grass seeds 10 – 20 g/m²	❶ grass seeds 10-20g/m²
❷	❷ 30 cm vegetation base layer gravel / compost 0/32 – 0/64	❷ 30 cm vegetation base layer gravel / compost 0/32 – 0/45
❸	❸ not necessary	❸ 20cm frost protection gravel 0/45 – 0/64

L = only pedestrians, M = small vehicles, S = fire engines

Material

Gravel turf can be built with material, which is regionally available in all European countries. Two major components are used 1/ natural gravel or recycling material like building rubble, 2/ organic supplements which can be compost or the original soil. For the vegetation layer grass seeds are used.

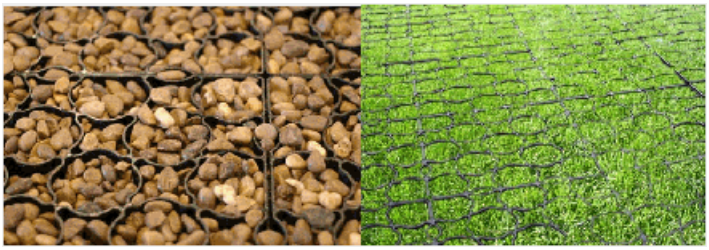
Subsoil

Gravel turf needs subsoil preparation to increase the stability, 1-layer gravel turf needs a subsoil layer of 30 cm, usually a mixture of gravel and compost
2-layer gravel turf needs to be applied when subsoil stability is not sufficient, an additional 20 cm layer needs to be applied

Run-off coefficient	0.1 - 0.3
Drainage	Gravel turf is one of the very few permeable surfaces which can be constructed without an additional drainage system.
Application range	Gravel turf is most suitable for parking areas with low or intermittent congestion. It may also be used for emergency access e.g. in parks or to residential buildings and for infrequently used roads. Gravel turf is also a suitable technology for tramway tracks, which are not or rarely frequented by car traffic (see also Best Practice).
Maintenance	The surface is maintained like a normal lawn and needs about 2 to 3 grass cuttings per year. In winter snow removal needs to be carried out with a highly elevated snow plug (3 cm above surface) and without road salt.
Benefits	1/ High water drainage capacity saves waste water costs, 2/ Landscape protection: gravel turf is not an optical intrusion like asphalt sealing, 3/ Regional materials: the required materials are easily available and don't need long distance transport, 4/ Reuse of recycling material is possible for the subsoil layer, in particular recycling material from the building industry
Limitations	1/ Permanent parking, 2/ highly frequented parking lots, 3/ barrier-free parking, 4/ winter maintenance, requires snow removal without road salt (which is common in many countries)
Costs	Simple and inexpensive construction, indicative costs are 15 to 2 € per m² (excl. VAT Conventional asphalt layers amount to approximately 35 – 40 €/m² in Germany, Austria, Italy (exc. VAT) No seepage water collection system needed.
Conclusions	Gravel turf is a long lasting ecological surface and is ideal for large parking areas which are not permanently frequented. The surface can also be used for day parking. The potential applications are by far not exploited; good examples are for instance the "green tramway tracks" (see also Fig. 77). Another benefit is the fact that the surface does not require an additional drainage system. The surface is maintained like a normal lawn and needs about 2 to 3 grass cuttings per year. Key barriers are currently lack of experience of builders and restrictions from the water authorities, who in many cases demand that drainage of large surfaces is directed to a sewage system

3.1.4 Plastic grass grids

Plastic grass grids look like conventional lawns, they are simple to install and low cost.



Left: grass grid unit, clips together
Above: the grid can be filled with gravel or grass seeds

Fig. 69 Grass grids – examples
Source: The Construction Centre [124]

Description	Plastic grass grids can be either filled with soil and grass seeds or with gravel
Material	Polyethylene (recycled versions available), grass seeds, original soil, sand, crushed rock and gravel
Subsoil	Plastic grass grids are installed on a crushed stone bed similar to gravel turf. For additional stability and frost protection a second layer of crushed stone is required (see Tab. 8).
Run-off coefficient	0.3 (90 % unsealed surface)
Drainage	Plastic grass grids can be installed without additional drainage systems.
Application range	Low frequented parking areas and gate ways
Maintenance	Regular maintenance by mowing and special snow removal (no road salts) necessary.
Benefits	Low cost, no run-off water management necessary, landscape protection, re-use of upper soil layer possible, use recycling material possible (recycled polyethylene)
Limitations	Not for permanent parking, not for regularly frequented parking, not for disabled persons parking (bad accessibility by wheelchair or crutches), requires regular maintenance (mowing) and special snow removal (no road salts), the material is sensitive to UV radiation and gets fragile.
Costs	Total costs per square meter are estimated to range between gravel turf and conventional asphalt layers; i.e. about 30 €/m². The plastic grid alone costs about 11 – 16 €/m² (excl. VAT) without sub-base and labour costs.

Conclusions Plastic grass grids improve the water drainage and storage capacity of surfaces and have a landscaping function. However, this solution is preferable for low frequented parking areas. The life span of the plastic grid is lower compared to concrete or gravel based systems.

3.1.5 Concrete grass grids

Concrete grass grids have a higher stability as plastic grids and last longer, but their installation costs are considerably higher.

Left: construction of grass grid surface
Above: parking area with concrete grass grids

Fig. 70 Concrete grass grids – examples
Source: Producer website

Material Concrete grass grids, grass seeds, original soil, sand, crushed rock and gravel.

Subsoil Concrete grass grids are installed on a crushed stone bed, for additional stability and frost protection a second layer of crushed stone is required. The grids are either refilled with original soil, humus and grass seeds or with gravel. The construction of the sub-base is similar to concrete pavers (see also Tab. 10).
Specific installing machines are available for larger surfaces.

Run-off coefficient 0.6 with gravel filling, 0.7 with humus and grass seeds
40 % unsealed surface

Drainage Run-off water need is usually directed to nearby drainage ditches.

Application range Car and caravan parks, fire access routes, footpaths, temporary car parks, and street verges.

Maintenance Requires regular maintenance (mowing) and special snow removal

	(no road salts).
Benefits	Run-off water management necessary in regions with heavy rainfalls (typically nearby drainage ditches). Reuse of upper soil layer possible Can be easily repaired. Green vegetation layer possible
Limitations	Not for barrier free parking, requires regular maintenance (mowing) and special snow removal (no road salts). The surface is very bumpy and not suitable for shopping trolleys.
Costs	Costs are about equal to concrete pavers and are approximately at 40 €/m² (excl. VAT).
Conclusions	Concrete grass grids are a long lasting solution and are also suitable for higher frequented parking areas. They have a landscaping function and increase the local water and storage capacity by at least 60 % percent compared to conventional asphalt layers. Major drawbacks are regular maintenance and the bumpy surface. They are ideal for highly frequented parking grounds at recreational sites.

3.1.6 Water bound surfaces (macadam)

Water bound surfaces are the most traditional type of semi-sealed surfaces. They are also known as gravel walks and dirt roads. Their application range reaches from walk ways to roads with low frequency, depending on subsoil layers. Compared to conventional asphalt surfaces water bound surfaces have considerably lower building costs but require higher maintenance.

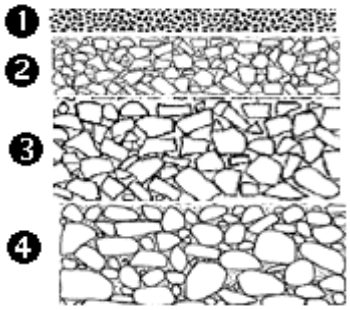
Water bound surfaces are supposed to be vegetation free. There a different design options possible with regard to the gravel colour of the surface layer and the boarder design.

Left: surface with rough grain size
Right: surface with finer grain size

Fig. 71 Water bound surfaces - examples

Tab. 9 Water bound macadam – technical description of layers and building material

Source: Green Concrete [119], City Planning Department Vienna [121]



	L = low frequency only pedestrians	M = medium frequency small vehicles	S = strong frequency heavy vehicles (fire engines)
❶	❶ 2 cm cover layer compressed sand 0/2[89] in urban areas 0/4 land scaping	❶ 2 cm cover layer compressed sand 0/2 in urban areas 0/4 land scaping	❶ 2 cm cover layer compressed sand 0/2 in urban areas 0/4 land scaping
❷	❷ 5 cm compensation layer in compacted form, crushed rock 0/8	❷ 5 cm compensation layer in compacted form, crushed rock 0/8	❷ 5 cm compensation layer in compacted form, crushed rock 0/8
❸	❸ 10 cm supporting layer in compacted form crushed rock 0/32	❸ 20 cm supporting layer in compacted form crushed rock 0/32	❸ 20 cm supporting layer in compacted form crushed rock 0/32
❹	❹ 13 cm frost protection in compacted form crushed rock 0/32	❹ 13 cm frost protection compacted form crushed rock 0/32	❹ 23 cm frost protection compacted form crushed rock 0/32

Material Water bound macadam can be built with material, which is regionally available in all European countries. Major components are 1/ sand, and 2/ crushed rock in different in grain sizes.

Subsoil Water bound surfaces are based on a very traditional technique. Different layers of gravel and crushed rock are applied. The grain size increases with the depth. Frost protection as bottom layer is applied.

Application range Walk ways and low frequented roads with a slope gradient of max. 2 %.

Maintenance Frequent repair of the upper layer (filling the holes)

Benefits 1/ High water drainage capacity saves waste water costs, 2/ Building effort and costs are low, 3/ Regional materials can be used, since gravel and crushed rock are available in most European countries, 4/ good walking comfort

Limitations 1/ Dust formation, the surface is not recommendable in highly wind exposed areas, 2/ Mud accumulation if water run-off is not managed properly, 3/ The upper layer needs regular repair, 4/ Unsatisfactory snow removal: because of the rough surface snow plugs have to be adjusted 3 cm above the surface. Residual snow remains on the street and either freezes or melts.

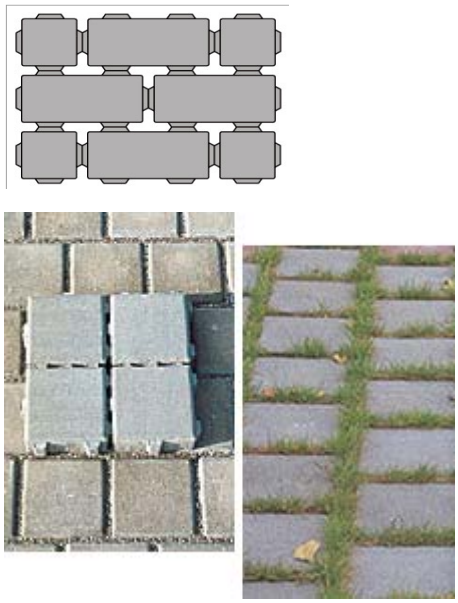
89 0/2 refers to particle size from 0 mm to 2 mm

Costs	Investment costs are about one third lower than conventional asphalt layers, and depend mainly on regional labour costs. Indicative costs for waterbound surfaces are 20. €/m² (excl. VAT) referring to Germany in 2010.
Run-off coefficient	0.5
Drainage system	Roads with a water bound macadam surface are usually built with side ditches for water drainage.
Conclusions	Major drawbacks of water bound surfaces are dust formation and unsatisfactory snow removal. This type of surface is only applicable for extremely low frequented roads and parking areas.

3.1.7 Permeable concrete pavements

In this section the two most common types are described, namely concrete blocks with voids, and permeable blocks without voids. The water seeps either through the voids between the blocks or through the porous blocks themselves.

Concrete blocks with voids are typically used in urban areas for highly frequented parking lots, gate-ways and courtyards. Concrete blocks are installed on a permeable, open-graded crushed stone bedding layer. The joints are filled with either with humus and grass seeds or crushed stones. Gravel fillings make the surface smother and are preferable for parking areas where shopping carts are used. A joint width of 3 cm is ideal for infiltration. In low infiltration soils some or all drainage is directed to an outlet via perforated drain pipes in the sub-base.



Left: examples showing the special shape of permeable concrete pavers
Right: parking area with permeable concrete pavers

Fig. 72 Permeable concrete pavers – examples
Source: [122]

Permeable concrete blocks consist of concrete made from tiny compacted pellets. This solid structure is porous i.e. water drains directly through the surface of the block. They are installed without open voids. The lower sub base consists of compacted gravel of 15-30 cm thickness, depending on use intensity and frost stability.

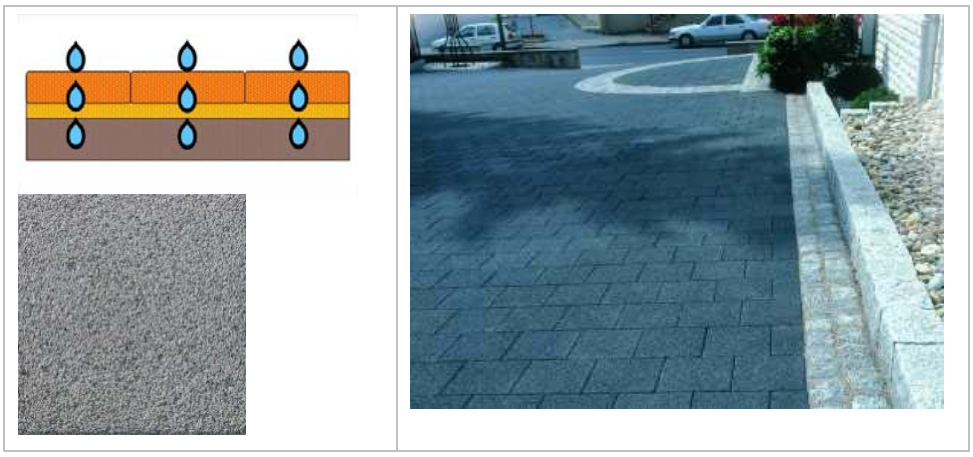
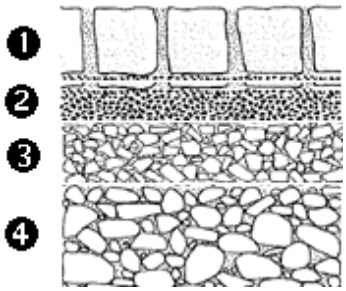


Fig. 73 Left: principle of permeable concrete blocks, right: parking area with permeable concrete blocks
Source: [123], [122]

Tab. 10 Permeable concrete pavers – technical description of layers and building material
Sources: [117], [120]

	L = low frequency	M = medium frequency	S = strong frequency
	❶ 6 – 8 cm concrete blocks joints: humus and sand	❶ 6 – 8 cm concrete blocks joints: humus and sand	❶ 6 – 8 cm concrete blocks joints: humus and sand
	❷ 4 – 2 cm compensation layer in compacted form, crushed rock 0/8	❷ 4 – 2 cm compensation layer in compacted form, crushed rock 0/8	❷ 4 – 2 cm compensation layer in compacted form, crushed rock 0/8
	❸ 10 cm supporting layer in compacted form crushed rock 0/32	❸ 20 cm supporting layer in compacted form crushed rock 0/32	❸ 20 cm supporting layer in compacted form crushed rock 0/32
	❹ not necessary	❹ 10 cm frost protection compacted form crushed rock 0/32	❹ 10 cm frost protection compacted form crushed rock 0/32

L = only pedestrians M = small vehicles S = fire engines

Material Both systems are made of concrete blocks and gravel. In the case of concrete blocks with voids humus, sand and grass seed are additionally used. All materials are regionally available in all European countries.

Subsoil There are various shapes of concrete pavers available. In order to increase the drainage capacity there are also special blocks of porous concrete available. In such cases the run-off water can seep through the joints but can also to some extent drain through the bricks.

Application range Parking lots, pedestrian paths, surfaces at industrial sites

Maintenance	Maintenance of the joints is required, in order to avoid plugging and loss of drainage capacity. The voids are cleaned with specific gravel exhausters and refilled with new gravel every 5 – 10 years.
Benefits	1/ Disruptions due to frost can be excluded, 2/ Partly permeable, 3/ Vegetation in the joints, 4/ Low maintenance, 5/ Low slip hazard when glazed frost, 6/ Visual appeal better than asphalt, great variety of design options (patterns and colours) Voids filled with gravel have a higher and longer lasting permeability.
Limitations	1/ Litter in the joints can lead to decreasing run-off capacity, 2/ Walking comfort is lower compared to asphalt, 3/ In low infiltration soils some or all drainage needs to be directed to an outlet via perforated drain pipes in the sub-base or to drainage ditches.
Costs.	Indicative costs for standard quality pavers are currently at 40 €/m² (without VAT, Austria, Italy, Germany). Premium quality pavers cost up to 60 €/m². Maintenance costs of concrete pavers are clearly lower. In the case of construction works brick pavers can always be recycled, whereas asphalt needs to be disposed of.
Run-off coefficient	0.5 - the joints amount to 20 % of the surface.
Drainage	Run-off water is typically directed to nearby drainage ditches.
Conclusions	Over their lifetime concrete pavers are more sustainable and cost less than conventional asphalt layers. In the case of road works the material can be entirely reused.

3.1.8 Porous asphalt

Porous asphalt requires the same building technique as normal asphalt. Porous asphalt consists of standard bituminous asphalt in which the fines have been screened and reduced, creating void space to make it highly permeable to water. The void space of porous asphalt is approximately 15 - 20%, as opposed to two to three percent for conventional asphalt.

(1) = conventional asphalt, (2) = porous asphalt with rough grain size, (3) porous asphalt with fine grain size.

Fig. 74 Porous asphalt – examples
Source: [118]

Material	Bituminous material, gravel
Subsoil	four layers: (1) 5 – 10 cm layer of asphalt, (2) 2 – 5 cm crushed aggregate, (3) 30 cm supporting layer of crushed rock (4) layer of geo-textile material.
Run-off-coefficient	0.6 - 0.7
Drainage	The requirements to drainage are the same as for conventional asphalt.
Application range	Roads, parking areas, large public surfaces and recreational surfaces
Maintenance	No regular maintenance required, renewal of the surface is more often necessary compared to conventional asphalt; approximately every 12 years compared 25 years.
Benefits	Dry surfaces result in higher road safety, no run-off water management necessary except in regions with extreme rainfalls, noise reduction/absorption
Limitations	Lower life span than normal asphalt, plugging of pores and reduction of drainage capacity
Costs	Costs are about equal to conventional asphalt surfaces, i.e. approximately at 40 – 50 €/m² (excl. VAT) but the life span and optimal functioning of the material is only half compared to conventional asphalt.
Conclusions	Porous asphalt has no landscaping function but can increase the local water storage and drainage capacity by at least 20 % compared to conventional asphalt.

3.2 Green Roofs

A green roof is a roof on a building that is partially or completely covered with a growing medium and vegetation, planted over a waterproof membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. The earliest known green roofs were turf roofs, a Nordic tradition still practiced today in many parts of Norway and Iceland. Turf was a durable and readily available building material known to have an insulating effect. Fig. 75 shows the principal components of green roofs.

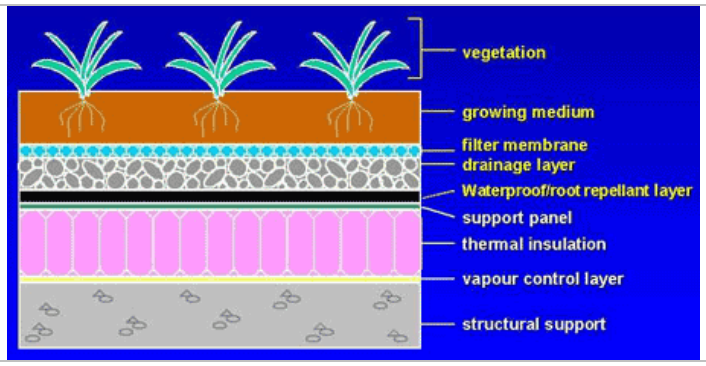


Fig. 75 Principal Green Roof components
Source: www.greenroofs.org, [125]

Green roofs can help to address the lack of green space in many urban areas. They are relevant for minimising some of the negative effects of soil sealing by moderating the urban heat island effect, improving the air quality by filtration of airborne particulates, providing an oxygen supply for humans and animals, creating a refuge for wildlife and retaining stormwater hence reducing the load on the urban sewage system.

Depending on the depth of planting medium and the amount of maintenance they need green roofs can be categorized as *intensive*, *semi-intensive*, or *extensive*. Examples are given in Fig. 76. Intensive roofs are thicker and can support a wider variety of plants but are heavier and require more maintenance than extensive roofs which are covered in a light layer of vegetation and are lighter.

Tab. 11 summarizes general features of green roof types.

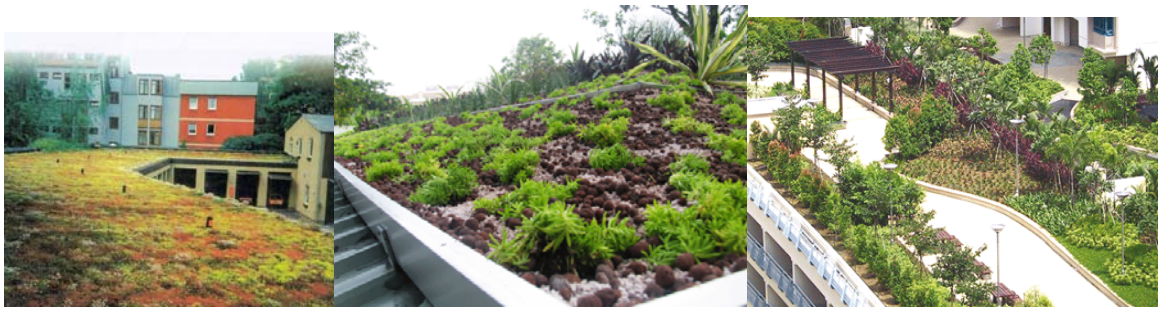


Fig. 76 Green roof types: extensive, semi-intensive, or intensive
Left: Extensive green roof
Middle: Semi-intensive green roof.
Right: Intensive green roof.

Tab. 11 General features of green roof types

	Extensive	Semi intensive	Intensive
Use	Ecological landscape	Garden, ecological landscape	Garden, Park
Type of vegetation	Moss, Herbs, Grasses	Grass, Herbs. Shrubs	Lawn, Perennials, Shrubs, Trees
Depth of substrate	60-200mm	120-250mm	150-400mm
Weight	60-150 kg/m^2	120-200 kg/m^2	180-500kg/m^2
Cost	low	periodic	high

Ecological benefits

1/ Water retention: depending on their design green roofs retain 50-90% of rain water
2/ Binding dust and toxic particles: 10-20% of the dust from the air are filtered
3/ Improved noise protection: reduction of sound reflection by up to 3 dB, improve the sound proofing by up to 8 dB
4/ Improved building thermal performance (insulation): A study conducted by Environment Canada found a 26% reduction in summer cooling needs and a 26% reduction in winter heat losses when a green roof is used. This reduced demand for energy would also mean a massive reduction of carbon dioxide production.
5/ Reduction of the urban heat island effect: Information from thermal studies, carried out at Trent University in the UK, found that on a typical day where ambient temperature was 18.4°C, a bare membrane roof had a surface temperature of 32°C. An identical roof covered with a thin layer plant system had a surface temperature of approximately 15°C.
6/ Biodiversity: refuge for wildlife in urban areas
7/ A larger living space: compensation for green spaces

Economic benefits

1/ Increased water retention: reduction of drainage costs
2/ Reduced renovation costs
3/ Reduced energy costs
4/ Substitute for lost areas of landscape
5/ Additional space

Disadvantages

1/ Higher initial cost
2/ Higher maintenance costs (however some types of green roof have little or no ongoing cost.)
3/ Restrictions involving climate and weather conditions (e.g.: rooftop gardens are inappropriate in very windy places; plants are fragile and can be blown away).
4/ Eventually, stronger roof beams are needed in order to support the several green roof layers (some existing buildings cannot be retrofitted with certain kinds of green roof because of the weight load of the substrate and vegetation exceeds permitted static loading.)
5/ More costly repairs and fixings (finding and repairing eventual leaks is more expensive and difficult).

Costs

Costs for green roofs vary very much between different countries, and

are generally higher in countries where there are few entrepreneurs that install green roofs. An extensive green roof is normally less expensive than an intensive one. Site-built green roofs are often cheaper than prefabricated mats. The following factors are affecting the price per metre:
1/ Size of roof – the larger the area the cheaper per square metre the roof will be
2/ Height of the roof. This will affect the price in terms of the cost of raising the elements to roof level
3/ Type of green roof
4/ Initial maintenance and establishment costs
5/ Type of waterproofing and insulation used (difference in labour costs)
6/ Other factors (Roof elements that intrude above the roof such as outlets, roof lights and industrial plant and other additions such as access hatches, safety lines can lead to increase in price per metre squared.)
7/ Involvement of manufacturers and contractors.
8/ Installation methods
Indicative costs for extensive sedum matted green roofs are 50 – 100 €/m² [126]

3.3 Legal requirements and incentives

Binding requirements to use permeable surfaces along construction are rare. The authors identified three legally binding systems and one system, which is based on monetary incentives.

3.3.1 Binding sealing limit in the City Dresden (DE)

The city of Dresden uses three legally binding instruments to reduce sealing along new construction activities [127].

- The Building Code[90] prescribes minimum criteria for the protection of landscape, nature and soils. In this context permeable surfaces for gateways, walk ways, and parking areas are prescribed and a clear reference to the use of permeable concrete pavers, gravel turf, plastic and concrete grass grids is made.
- Specific Construction Permits clearly prescribe a sealing limit for gateways, walk ways, and parking areas.
- The municipal Parking Space Ordinance[91] limits soil sealing along the construction of new parking areas, the use of permeable surfaces is compulsory.

3.3.2 Sealing Index in the Province Alto Adige (IT)

In the province Alto Adige the limitation of soil sealing is prescribed in the municipal zoning plan and the corresponding municipal construction ordinances[92]. In 2002 the provincial law

90 Grünordnung § 9 Abs. 1 Nr. 20 Baugesetzbuch (BauGB)
91 Satzung der Landeshauptsadt Dresden über Stellplätz und Garagen, February 2001
92 Norme di attuazione al piano urbanistico / Durchführungsbestimmungen zum Bauleitplan

no. 8 „Water Regulation“ was enforced defining new regulations for run-off water management and limitation of sealing. Two years later the *Sealing Index*[93] methodology was approved. This methodology is based on calculating the most sustainable sealing rate for properties where new construction projects are planned but also for restructuring projects. The principle is executed at the municipality level and is defined in the municipal zoning plans and the corresponding municipal construction ordinances. Overall objective is to enforce surface drainage by using permeable materials, but also green roofs, and traditional vegetation [128], [116].

3.3.3 Permeable surfaces without planning permission (UK)

Policy promoting the use of Sustainable Urban Drainage (SUD) systems in the UK is relatively advanced; at a high level SUDs are explicitly promoted in Planning Policy Guidance 25 to prevent urban flooding [129]. Moreover, this is promoted at the development plan level and by local authorities especially within the London Boroughs i.e. Islington and Ealing. In addition, in England the permitted development requirements for households have recently changed meaning that surfacing of front gardens with permeable surfaces (refer to section on permeable driveways) does not require planning permission, while the use of impermeable surfaces requires planning permission. There are therefore tools in place to promote SUD use generally and specifically address the consequences of local, small scale sealing.

3.3.4 Binding sealing limit in the City Vienna (AT)

For new development areas *Specific Construction Permits* are issued by the city planning authorities, which prescribe permeable surfaces for gateways, walk ways, and parking areas [130].

3.3.5 Tax incentives in several German municipalities

German municipalities are in charge of collecting the *Rain Water Tax* from real estate owners. The tax refers to rain water that is being directed to the municipal sewage system. The calculation of the tax is usually based on the size of the sealed surface. Some municipalities provide tax reductions for the installation of rain water collection systems or the use of permeable surfaces instead of asphalt layers. However, the tax as such is not very high and resulting reductions are too small to influence building techniques. To give an example, in the case of the municipality Wuppertal the tax incentive would result in 3 € per parking space and year if adequate permeable paving is installed[94] [131]. From an economic point of view the construction of a rain water collection system makes more sense to house owners. Rain water can be stored in a reservoir and used for irrigation, which saves water costs.

3.3.6 Green roof subsidies

In **Austria** green roof policies were introduced in Linz in 1985 as part of legally binding and compulsory building plans. It was one of the first cities in the world to have a compulsory green roof policy. In 1989 the City of Linz started with a generous financial incentive for build-

93 B.V.F. - Verfahren (Beschränkungsindex der versiegelten Flächen)

94 The municipality Wuppertal charges 1.9 € per m² sealed surface and year. Tax reductions of 30 % are granted for permeable pavers, 50 % for green roofs, and also 50 % for the installation of rain water collection systems. A large supermarket with 100 parking spaces (approx. 1.000 m²) would save 570 € per year.

ing owners, by sponsoring green roofs up to 30 % of total investment costs. This subsidy was later reduced in 2005 to 5 %. The total area prior to 2007 was 400,000 m² (equivalent to 40 soccer-pitches). About 90% of this area are extensive green roofs and 10 % intensive green roofs [126].

In **Germany** policies to encourage green roof construction exist at all levels of jurisdiction; at the national, federal, and the municipal level. German green roof policies, many of which have been in place for over a decade, fall into four general categories [132]:

- direct financial incentives (subsidies)
- indirect financial incentives (split wastewater fees)
- ecological compensation measure; and
- integration into development regulations.

In 2003 green roofs made up 14 % of total roof area in Germany. In the 1990ies several German cities started to levy commercial buildings related to the amount of sealed ground space they occupy. For example in Berlin this tax amounted to 2 € per m² per annum. A reduction of 50 % of this tax rate is applicable for buildings that have planted roofs. Similar taxation and incentive schemes operate in Bonn, Munich and Stuttgart. For these reasons the roof space covered by greenery in German cities has increased at an astonishing rate. In 1995, 10,000,000 m² of roof space had been greened. By 1999 this figure had risen to 84,000,000 m². Nearly one third of all cities have regulations to support green roof and rain water technology [132].

Denmark: As part of its overall strategy to become a carbon neutral city by 2025, Copenhagen has become the first Scandinavian city to adopt a policy that requires green roofs for all new buildings with roof slopes of less than 30 degrees. Copenhagen presently has 20,000 square meters of flat roofs. It is hoped that as much as 5,000 square meters of new development each year will be covered with vegetation [133].

The **UK** do not have an explicit national policy that requires or encourages the use of green roofs, however there are key national policies that support them. These include “Securing The Future” – the UK Government’s sustainable development strategy 2005, and “Climate Change” – the UK Programme 2006. The use of green roofs is also consistent with other planning policy statements and guidance documents such as PPS1 - Delivering sustainable development,PPG2 - Green belts, PPS3 – Housing, PPS9 - Biodiversity and geological conservation,PPG17 - Planning for space, sport and recreation and PPS25 - Development and flood risk [126].

The Netherlands: Examples of Dutch cities that have policies to support the implementation of green covered roofs are Groningen, Rotterdam, Amsterdam and The Hague [134].

- In Groningen private households can obtain subsidies for green roof construction, amounting to € 30 per square metre. The subsidy is limited with a maximum of €1.500.
- In Rotterdam subsidies are available from the city government, amounting to €25 per square metre, another € 5 per square metre can be obtained from the district water board.
- In Amsterdam a subsidy of € 20 per square metre to a maximum of €1.000.can be obtained.
- In The Hague a subsidy of € 25 per square metre to a maximum of €20,000 is available.

3.4 Research

Carbon Footprint of Pavements in Urban Space. A detailed survey of the City of Vienna compares the carbon dioxide emissions and sustainability of various pavement systems over their lifetimes. The study considers (1) the origin of materials and their transport impact, (2) maintenance efforts and costs, and (3) waste production and material reuse. A key conclusion of the survey is that material transport is the highest contributor to overall CO_2-emissions of pavement systems and that higher investment costs of permeable pavers are outweighed shortly after their installation due to lower maintenance costs [121].

Cost benefit analysis of permeable and impermeable surfaces [114]. A survey completed in 2008 for CIRIA (Construction industry research and information association) demonstrated relatively low awareness among the public regarding legislation but also existing techniques. Moreover general knowledge towards the environmental need to undertake, for example, the use of permeable surface solutions was observed to be low. The latter has the potential to result in resentment on the part of property owners when they are required to undertake action. The same survey also identified that the awareness of the issues by installers, merchants, retailers, etc was thought to be problematic. The survey concluded that 'There was also thought to be a lack of communications between authorities to determine best practice for materials and specification. Lack of contractor skills, knowledge, familiarity and effective training with regards to implementation of permeable surfaces was considered to pose a significant challenge that needs to be addressed'.

The CIRIA study also identified that industry awareness differed depending upon the technology to be employed. For example there were relatively high levels of understanding in terms of how to install permeable block pavers and their use, with medium levels of understanding regarding the use of reinforced grass and gravel systems. There was little understanding of the use of porous asphalt either domestically or commercially. This variation in awareness regarding the use of relatively common SUD solutions i.e. permeable surface materials, is coupled with concerns over the skills available to install and availability of materials on the market place.

3.5 Best practice

3.5.1 Green tramway tracks

Green tramway tracks are getting more and more popular (see examples Fig. 77). They improve the visual appearance of towns and have an additional drainage function in urban areas. In the city of Graz a novel gravel turf technique was applied on a pilot track of 130 m length. The subsoil preparation included a high share of recycled building rubble and a high share of compost in the vegetation layer. The resulting surface does not require any maintenance (gras cutting) due to the frequent circulation of the tramway.

Fig. 77 Graz (AT), Mulhouse (FR): Green tramway tracks
Source: [135], [119]

3.5.2 Sustainable Urban Drainage (SUD) Systems

Showcase for SUD techniques. A new residential development of 35 affordable homes was built on a one hectare site in the UK. The project shows the full range of possible Sustainable Water Management Techniques within residential developments, including among other SUD techniques[95] such as permeable paving, water butts; a green roof; swales; detention and wetland basins; and a retention pond. The aim is to control the runoff starting as close as possible to its source.

Fig. 78 UK: Examples for Sustainable Urban Drainage Systems
Source: [113]

3.5.3 Permeable Driveways

In the UK people are increasingly paving over their front gardens to provide parking for cars but also for easy management of land. The Ealing Front Garden project aims to reduce seal-

95 Other applied SUD techniques: water butts, green roofs, swales, detention and wetland basins; and a retention pond

ing in front gardens and to convince the local population about the benefits of greening and permeable pavements. The project was established under Ealing Borough Council's Agenda 21 programme and funded by the local Council. A survey of front gardens in Ealing showed that the average front garden in the borough has 68% of its area covered in hard surfacing. In October 2008, largely in response to extensive flooding in several cities in 2007, limited controls on front garden hard surfacing came into force. (The Town and Country Planning Order 2008 requires front garden hard surfacing of more than five square metres in area to either be made of porous material or, if an impermeable surface, to direct runoff to a soakaway area or rainwater storage within the property's boundary or require planning permission, the application to include a scale drawing and a fee of £ 150.)

The project builds on awareness raising, public participation, practical and legal advice for citizens [137].

Fig. 79 UK: The Ealing Front Garden Project
Source: [137]

3.5.4 Parking for the masses

The sealing of large open air parking areas for large visitor streams, like at soccer stadiums, at trade fairs, or in skiing resorts poses several problems. The large sealed surfaces increase the local flooding risk. In many cases these areas are most of the time empty, because they are only seasonally frequented or only for a few hours. Large asphalt areas are always a visual nuisance.

EXPO 2000 World Exposition. The parking area of the EXPO 2000 World Exhibition is the largest parking area with permeable surfaces. The area has the capacity for 25,000 cars and 1,600 busses. In total an area of 300,000 m² was paved with permeable concrete blocks. At the outer and less frequented parking area gravel turf was applied.

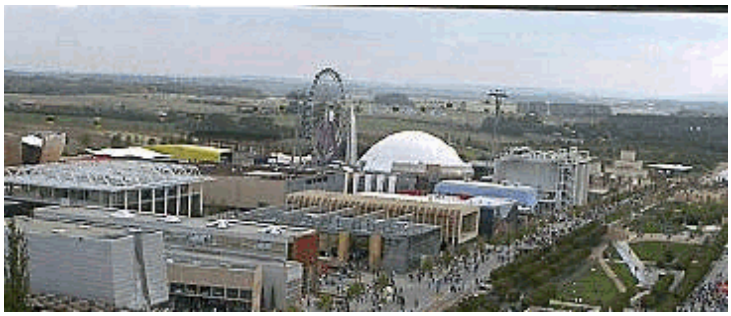


Fig. 80 Germany: EXPO 2000 parking area in Hannover
Source: [138]

Soccer Stadium Salzburg. The stadium was enlarged and adapted for the Euro Masterships in 2008. The parking area has a capacity of 2,000 cars and has a gravel turf surface.

Fig. 81 Austria: Parking area of the Salzburg soccer stadium.
Source: [130]

3.6 Summary

Permeable surfaces can replace soil functions and mitigate the effects of soil sealing to a limited extent. They increase the local water drainage capacity and can in some cases also fulfil biological or landscaping functions. Presently there is no information in order to quantify the application of the single surface types described.

Green roofs generate new green space and create an added value to the quality of living in particular in very densely built areas. However, they can not necessarily be classified as instruments to reduce soil sealing.

A broad range of materials and concepts is available for permeable surfaces. In addition to their clear ecological advantages most types of surfaces have lower lifespan costs compared to conventional impermeable surfaces. With regard to sustainability it can be said that most permeable surfaces are made of materials that are locally available and reusable.

Barriers to implementation. However, there is not one unique permeable surface that can serve all purposes. All share the fact that site specific know how and building competence is required to construct them correctly. Maintenance is needed to make sure that they function properly. Currently major barriers to the implementation of permeable surfaces are as follows.

- Controversial building legislation. In many cases conventional pavement and the direction of rain water to the sewage system are stipulated by the building license. This is often the case for large parking areas, where contamination of the run-off water is assumed.
- Lack of know-how is currently the greatest barrier to a wider application of permeable sur-faces. Therefore conventional asphalt techniques prevail (everybody knows how to do it).
- Prejudice. Permeable surfaces have the reputation to be either expensive or to be troublesome. “The expensive eco stuff makes sludgy puddles” is a common opinion. Bad building practices have supported this prejudice.

Missed opportunities. Parking areas have the greatest potential for permeable surface application. In Europe there are definitely more parking lots than cars. The number of cars is increasing from year to year and together with this trend also the number of parking lots.

- Recreational sites. The application of reinforced grass systems with gravel or grass grids is ideal for large short-term used parking areas, like in ski resorts, soccer stadiums, golf courts, touristic sites, and trade fairs. Such surfaces improve the local drainage capacity and contribute positively to the landscape.
- Households. Private driveways have great potential for the application of permeable surfaces. For this type of use almost all surfaces types are applicable.
- Supermarkets. The use of permeable concrete pavers in combination with drainage ditches is a long lasting solution which allows heavy traffic. This type of surface is more and more applied at supermarket parking areas.

Limitations. Areas with sensitive groundwater resources or shallow groundwater (below 1 meter) are in general not suitable for surface drainage.

Costs. Apart from natural stone pavements, it can be said that permeable surfaces do not bear higher costs than conventional asphalt and are not dependant on the crude oil price (unlike asphalt).

Sustainability. Gravel turf and concrete bricks are made of sustainable materials, which are readily available in most European regions. As these materials can easily be reused their life span is almost unlimited. Conventional asphalt on the contrary has to be recycled for re-application with more energy input.

Trends. Many planning authorities in Europe are currently revising their technical regulations towards surface sealing. Increased drainage capacity has many advantages, in particular in areas with flood risk or overloaded sewage systems. The fact that permeable surfaces can reduce or even avoid costs related to flood prevention, flood damage repair or enlargement of existing sewage systems is attractive for local planning authorities. For example, planning

authorities in England, in the Alto Adige region (Italy), and selected cities in Germany and Austria already restrict surface sealing for new building activities.

4 COMPENSATION SYSTEMS

This chapter refers to systems which aim to compensate for soil loss through sealing. The authors were able identify three different types of compensation.

- compensation payments,
- compensation measures, and
- trading systems.

It has to be noted that all three types refer to land take, meaning that the focus is on the conversion of biologically functional soils to building land. As explained previously, built-up land is generally only partly sealed. In the following sections the three systems are explained and practical implementations are explained.

4.1 Compensation payments

This method is based on the principle that soil consumption is charged with a fee. The payments are dependant on the quality of the consumed soil. This method is applied in several countries and regions with the intention to conserve the best agricultural land. The payments are usually related to soil fertility classes. In the following 3 applications are described.

4.1.1 Compensation payments for agricultural land in the Czech Republic

Until the early 1990ies the loss of agricultural land was constantly increasing in the Czech Republic and new developments were mostly realised on the best soils. Shortly after its independence the former Czechoslovakia[96] enforced an *Act on the Protection of Agricultural Resources*. The system defines five classes of agricultural land of which the classes I and II are the most fertile and productive ones. The conversion of Class I and II soils requires a special permit and is connected to a fee directed to the State Environment Funds[97]. Based on a fee ranging from 8 to 28 Cent/m² - depending on the soil fertility - the average annual income created by this instrument amounted to 20 million Euros between 2000 and 2008 and decreased continually (see Tab. 8). The Czech Ministries for Agriculture and Environment are currently preparing an amendment of the Act on the Protection of Agricultural Resources in order to increase the fees for withdrawal of land from the agricultural land resources. [24].

96 The law was enforced in Czechoslovakia in 1992. One year later Czechoslovakia dissolved peacefully into its constitutent states the Czech Republic and Slovakia. This regulation was taken over by both countries.

97 Státní fond životního prostředí ČR

Tab. 12 Yearly income of the State Environment Funds
Source: Ministry of the Environment [24]

Year	Total income in CZK	Total income in €
2000	787.200.000	31.488.000
2001	561.000.000	22.440.000
2002	590.500.000	23.620.000
2003	572.500.000	22.900.000
2004	410.200.000	16.408.000
2005	484.500.000	19.380.000
2006	516.700.000	20.668.000
2007	280.700.000	11.228.000
2008	334.100.000	13.364.000

With regard to loss of agricultural land, three key aspects are regulated in order to minimise such a loss:

- A distinction of five soil quality classes is made, with special protection of the best two classes.
- A special permit is required for developments on agricultural land of good quality. For large development areas, such decisions are not made by the local municipality but are forwarded to higher level authorities.
- If a development on good agricultural is unavoidable (no alternative solution) there is an obligation to minimise the extent of land take as far as possible.

The soil classes are defined as follows:

- Class I: Soils judged most valuable in each climate region, which may be exempted from the agricultural fund only as an exception.
- Class II: Soils whose productivity is, within the climate region, above standard.
- Class III: Soils with average productivity and medium protection level, which may be used for construction purposes.
- Class IV: Soils mostly below average productivity, which may be used for construction purposes.
- Class V: Soils with very low productivity, which are considered dispensable for agricultural purposes, which may be used for construction purposes.

The permits for the conversion of agricultural land are issued at different authority levels depending on the size of the area in question.

- up to 1 ha - municipalities of the 3rd level
- from 1 to 10 ha - regional offices
- over 10 ha - Ministry of environment

The special conditions for the conversion of agricultural land to building land are specified in Article 4, which requires “If it is inevitable to take agricultural soil for non agricultural purposes, it is necessary 1/ to minimize disturbing of land consolidation and hydrology conditions, 2/ to minimize the area of the land taken, 3/ to minimize land management, especially

in line constructions, 4/ after finishing construction works to take necessary measures assure good agricultural management".

For the protection of forest soils similarly conditions apply and are regulated in the Forest Act 98.

Tab. 13 Fees for the conversion of agricultural land
Source: Ministry of the Environment [24]

Class of protection	I	II	III	IV	V
CZK / ha	69.413	58.440	53.356	43.971	20.695
Euro / ha	2.776	2.338	2.134	1.759	828
Euro / m^2	0,28	0,23	0,21	0,18	0,08

Conclusions. Some experts are of the opinion that the regulation is rather ineffective in particular in the Prague agglomeration, where land take is enormous. The affected soils in this region are entirely of the best quality and there are no alternatives. Because of the economic pressure too many permits are issued. However, the overall statistics show a stagnation of loss of agricultural land since law enforcement

4.1.2 Compensation payments for agricultural land in Slovakia

The Slovakian system is very similar to the Czech Republic and is regulated by the Act on Protection and Utilisation of Agricultural Soil[99]. In total there are 9 soil classes and the best four classes are protected. The conversion of such land into building land is charged with a fee for each square meter of lost soil. The system is regulated by the regional agricultural bureaus, who can issue permissions to use agricultural soils. There is a detailed information system about protected and other soils available in order to manage agricultural soils. Major objective is to protect the best soils and to direct new development to sites with poor soil conditions.

The conversion of protected land to building land requires a fee, depending on the quality of the affected soil, ranging from 6 – 15 Euros per m², depending on the soil quality. Currently 21 % of the Slovakian agricultural soils are affected by this protection regime.

The fee on the use of agricultural land goes to a national funds, the income is used for soil protection and soil quality monitoring.

98 Act No. 289/1995 Coll.
99 No. 220/2004

Tab. 14 Compensation payments for agricultural soils in Slovakia
Source: Soil Science and Conservation Research Institute

	Percentage of total agricultural soils	Quantity in hectare	Fee
Highly protected soils	3.9 %	99,800 ha	15 € / m²
Strong protected soils	8.5 %	215,800 ha	12 € / m²
Protected soils	5.8 %	147,300 ha	9 € / m²
Less protected soils	2.9 %	72,700 ha	6 € / m²

Conclusions. Since independence Slovakia was highly affected by loss of agricultural land due to land developments and sealing. In the period of 1990 – 2008 the loss of agricultural land amounted to 33,116 hectare, corresponding to 1.3 % of the available agricultural land and to 5 hectares per day or 3.4 m² per inhabitant and year. In 2004 the Act on Protection and Utilisation of Agricultural Soil[100] was enforced which represents a tool to mitigate the loss of agricultural soils and to steer new developments to soils of lower quality. *"It would be worse without"* is the common expert opinion in Slovakia. Compensation measures

Compensation measures build on the principle that soil consumption and hence the loss of soil functions (biodiversity, fertility, drainage capacity, erosion protection etc.) is compensated with restoration of soil functions somewhere else.

European practice. Compensation of ecological losses caused by major construction works exist in several countries. However, in most cases compensation mechanisms focus on ecological compensation in general and neglect the loss of unprotected soils. In the Netherlands, the compensation measures are focused on certain protected areas. In the UK there are few legal instruments that formally require environmental compensation. In Sweden there are legal demands that environmental compensation is carried out in the case of exploitation works. The German environmental compensation practice is most developed and considers also conventional soils. Compensation is co-ordinated by *eco-account* agencies in the German Federal States. In Austria a pilot application is currently planned which will be implemented in the Southern agglomeration of Vienna [140].

4.1.3 Ecological compensation for highway construction in the Netherlands

As early as 1993 the principle of ecological compensation to reduce ecological losses of major infrastructure projects (in particular highways) has been incorporated in Dutch governmental policy[101]. The overarching principle of the compensation mechanism is *"prevent, limit, compensate".*

However, a recent survey states that compensation measures in the Netherlands proved to be inefficient. Only half of the land which was classified as to be compensated was actually compensated. Major reasons were the lack of severe sanctions if compensation was not carried out and the lack of simple procedures for investors. The survey concludes that in order to improve the system professional compensation banks or local compensation pools were necessary. This would ensure that compensation measures were carried out by experts

100 Act No. 220/2004 Coll. on Protection and Use of Farmland
101 Ecologische Hoofdstructuur (EHS), 1993

[139].

4.1.4 Eco Accounts in the German Federal States

Background. In 2002 the National Nature Conservation Act[102] was enforced, which requires that impacts to nature have to be compensated. This requirement does not only refer to loss of soils but also to major losses of biodiversity and species. The need for compensation is specified by the responsible planning authorities. Typical projects that would require compensation are for instance large infrastructure developments like the building of streets and air fields or new development plans of municipalities and cities. In the first enforcement phase compensation measures were carried out by the intruding parties themselves. This procedure was in many cases not satisfactory for both sides. Planning authorities were often confronted with a lack of quality regarding compensation measures and developers were confronted with additional complications regarding legal procedures. Besides that, the rules for compensation were not clearly defined. As a reaction to this unsatisfactory situation several Federal States introduced the Eco Account System, which is supposed to bring more fairness and transparency in the compensation process and is a clear facilitation of procedures for developers.

Methodology. The eco-account system is based on trading eco points. Developments requiring nature compensation measures according to the National Nature Conservation Act are charged with eco points. Developers have to prove that compensation measures of equal value are being carried out somewhere else. Eco points can be acquired at compensation agencies, which are officially authorised and carry out compensation measures. Compensation agencies are owners of Eco Accounts, selling eco points and are in charge of realising compensation measures. Typical compensation projects are for instance the improvement of

- biodiversity at habitats and protected landscapes,
- of agricultural practices by switching from intensive to extensive management forms, and
- forest management practices.

Implementation. So far 21 authorized eco account agencies exist all over Germany. Their portfolio of compensation measures and their trading area differs considerably. Examples from German Federal States:

- **Hessen** was the first German Federal State, which implemented the Eco account system. Compensation measures are based on the regional Compensation Decree[103] and are coordinated and supervised by the compensation agency *Ökoagentur für Hessen*[104]. The compensation agency coordinates all measures to be taken for compensation and thus separates compensation activities from the overall planning agenda and time schedule. The developer receives a certificate stating that compensation was done according to law and thus is able to proceed with the project concerned, while compensation is implemented in a coordinated and structured way on land that is appropriate (and not just available in short period of time) and

102 BNatSchG 2002 (nature conservation act): compensation of an environmental Impact in the case of building measures. (§19; §21(1))

103 Verordnung über die Durchführung von Kompensationsmaßnahmen, Ökokonten, deren Handelbarkeit und die Festsetzung von Ausgleichsabgaben (Kompensationsverordnung - KV) Vom 1. September 2005
Translation: Decree on the Realisation of Compensation Measures: Eco Accounts, Tradability and Fixation of Compensation Payments. As of September 1, 2005.

104 Ökoagentur für Hessen (http://ökoagentur-hessen.de/)

without time pressure. Projects are done under scientific supervision, in cooperation with universities.

- The portfolio of the agency includes currently 3 compensation projects, two being habitats, and one for agricultural practices; i.e. from intensive land use to extensive and/or organic agriculture. The price of one eco-point is defined per law with 0.35 €

- **Schleswig Holstein** Compensation measures are coordinated and supervised by the *Ausgleichsagentur*[105]. The agency is in charge of more than 40 compensation measures, all of which refer to the improvement of biodiversity at habitats and protected landscapes.

Costs: Preliminary information refers to costs for developers ranging between 1 – 5 Euros per m² land take and more than 5 Euros per m² sealed soil. In Hessen the costs for one Eco Point are officially fixed with 0.35 €. Sealing of soil with poor quality would roughly cost 20 Eco Points or 7 Euro per m².

Conclusions. Advantages. The eco account system represents an added value for compensation measures. 1/ The quality of measures is better controlled, 2/ measures are pooled and larger projects are facilitated, 3/ the system provides more transparency and fairness, and 4/ the procedures are easier for developers. Drawbacks. Compensation measures 1/ are not focused on soil sealing and land take but on impacts to nature in general, 2/ there is no limitation to soil sealing or land take (it is just about extra costs), and 3/ the costs of compensation measures seem to be very moderate.

4.1.5 Soil compensation account in Dresden (Germany)

The most remarkable compensation measure is the *Soil Compensation Account* (Bodenausgleichskonto) of the city of Dresden which was established in the year 2002. Legal basis of this system is also the National Nature Conservation Act. Dresden has established a special compensation mechanism which focuses on desealing and removal of derelict buildings. Also noteworthy are the actual compensation fees, which are based on “real costs” of desealing and amount to approximately 20 € per m² desealed soil.

The City of Dresden has defined a long term planning target which declares that built-up land for settlements and traffic is to be confined to 40% of the total urban land. To meet this goal the city council established a “soil compensation account” (Bodenausgleichskonto). New developments on undeveloped land require adequate desealing measures or “greening” measures somewhere else but within the city boundaries. Developments in the inner urban area are usually exempted from compensation measures with the objective to steer inner urban developments and stop urban sprawl. Developers have the opportunity to carry out compensation measures by themselves or to pay a compensation fee to the Environment Authority of the City, who is in charge of several desealing projects.

Since 2000 the city monitors sealing and desealing within the city boarders. On average about 4 hectares are desealed per year (see Fig. 82).

105 Ausgleichsagentur SH GmbH (http://www.ausgleichsagentur.de/)

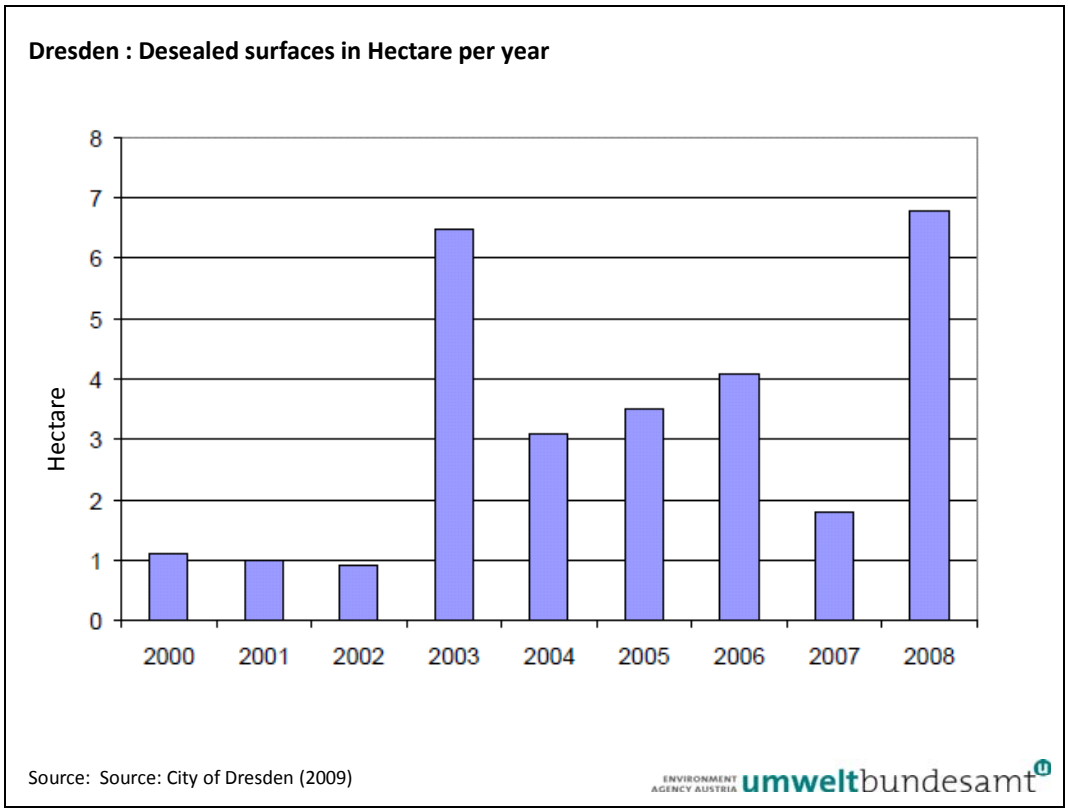


Fig. 82 Development of desealing in Dresden
Source: City of Dresden (2009)[106]

Conclusions. The soil compensation account of the city of Dresden clearly refers to desealing measures and the sealing policy of the city. According to the city planning authorities the measure is effective but is regarded as financial obstacle by investors. The compensation fee for sealing is considerably higher compared to other compensation measures, which focus merely on compensation of biodiversity losses (*"planting a few shrubs is much cheaper than desealing and disposal of demolition rubble"*). According to local experts the survival of this measure is in danger because it is perceived as barrier for investors as Saxony, with 12 %, has one of the highest unemployment rates among the German Federal states.

4.1.6 Landscape Compensation Account in the Vienna agglomeration (Austria)

In Austria a *Landscape Compensation Account* will be tested in a pilot implementation in the South of Vienna. The German Eco Account System serves as a role model.

In Lower Austria and in particular in the Southern Vienna agglomeration several large infrastructure projects will be realised in the near future. Among them are the enlargement of the Vienna airport, the extension of streets and railway network. All projects will result in severe impacts on soils and landscapes but cannot be realised somewhere else from a strategic point of view. In order to mitigate the effects of the planned projects compensation in the style of the German Eco Account system is planned. In a first step the City of Vienna and the

106 Source: Wolfgang Socher (wsocher@dresden.de), Landeshauptstadt Dresden, Umweltamt

adjoining province Lower Austria agreed on developing common compensation projects and on establishing a joint "Landscape Account".

Conclusions. The Landscape Compensation Account in the Vienna Agglomeration is currently in the planning phase. The fact that the planning authorities of the city and the connected province are aiming to co-operate on compensation measures is highly innovative.

The planned projects are requiring compensation according to the Environmental Impact Assessment Directive[107]. However, such compensations are usually handled very low level, since there are no clear guidelines and the control is almost nonexistent. The Landscape Compensation Account would mean an improvement of compensation measures at large, since larger projects would be facilitated and managed professionally.

4.2 Trading of soil certificates

The most remarkable compensation system is the *trading of development certificates*. The system has been intensively discussed in Germany and is considered to be the most effective measure to achieve sustainable land use on a short and long term basis. The overarching principle is to create a shortage of building land; this mechanism puts an enormous economic pressure on land use and triggers the implementation of all possible instruments to reduce land take. As a result functional soils are only converted to building land if no other option is in place.

The logic of the system is comparable to the CO_2 emission trading systems of the Kyoto Protocol. Key barrier of the trading system is its complexity, since it requires the establishment of an entire market with trading mechanisms and commonly accepted rules. Along the experiment *Spiel.Raum*[108] the implementation of *Tradable Development Certificates* was simulated in 14 German municipalities of different size and all over Germany. The sample included a large diversity in terms of size - the largest municipality being Munich with one million inhabitants and the smallest cities with less than 10,000 inhabitants - and land use demand. The experiment was carried out over two years (Feb. 2007 – April 2009) and included four workshops and two trading phases [141].

Step 1: Calculation of future development land. Municipalities had to calculate their demand of building land for the next 15 years. The calculation had to respect common rules and the principles of efficient land use.

Step 2: Distribution of development certificates. All municipalities were assigned with development certificates according to the same rules. Two scenarios were considered, firstly a reduction of 13 % and secondly a reduction of 24 %. For example a municipality calculated their development need with 1,000 hectares. For scenario 1 they received development certificates worth 870 hectares and for scenario 2 only 760 hectares. The first distribution of development certificates is without any charges. The trading involves costs. The price per m² cannot be predicted but is dependant on the demand of certificates.

Step 3: Simulation of 15 year land development. The next 15 years were simulated. Municipalities had the choice to either go along with the stock of development certificates they received at the beginning or to engage themselves in trading development certificates. The first option means that a municipality uses their development certificates for their own develop-

107 Environmental Impact Assessment

108 Küpfer C. et al. (2010) Handelbare Flächenausweisungszertifikate. Experiment Spiel.Raum: Ergebnisse einer Simulation in 14 Kommunen (translation: Tradeable Development Certificates. Experiment Soil.Raum: results of a simulation in 14 municipalities.) in Journal Naturschutz und Landschaftplanung no. 42 (2) 2010, pp 39 – 47-

ments plus exploits all possible land use potentials, i.e. reuse of underused land, development of inner urban areas, renovation of existing buildings etc. The other option is to trade development certificates with other municipalities. Selling development certificates results in an income for municipalities. Acquiring certificates can also be economic if a municipality has a shortage of certificates and the planned development promises to outweigh the costs. In any case will municipalities aim to avoid consuming development certificates. The trading was simulated in two phases. Trading was possible via the internet and municipalities had to realise their development targets for streets, housing and business locations.

Conclusions. Results of the simulation revealed that both reduction targets (-13 % and -24 %) were reachable. Another observation was that most municipalities preferred to use their certificates in combination with efficient land use in stead of buying new certificates. This resulted in a rather moderate demand but also moderate supply. Key conclusions were:

- The trading mechanism strengthens the calculation of long term planning costs and the implementation of efficient land use management practices.
- For practical implementation it is necessary to achieve acceptance among decision makers and to build-up specific competence.
- With regard to the distribution of certificates it is difficult to achieve fairness and acceptance.

4.3 Summary

Three compensation systems and their practical application were analysed, namely compensation payments, compensation measures, and trading systems. The three systems refer to land take and only indirectly to soil sealing.

Compensations fees for valuable agricultural soils are currently charged in the Czech Republic and Slovakia.

1/ In the case of the Czech Republic the overall loss of valuable agricultural land stagnates since implementation of the legislation. However, the loss of top soils in the Prague agglomeration is still enormous as there are no alternative development areas in the region.

2/ In the case of Slovakia the loss of top quality agricultural soils is charged with 6-15 €/m². However, the annual loss of agricultural land is still at a very high level in Slovakia and the compensation fee is no barrier for investors.

In general compensation fees mitigate the loss of agricultural soils and steer wherever possible new developments to soils of lower quality. In both countries the income from the fee is used for soil research and statistics According to national experts the tool has “soothing effects” and the soil loss “would be worse without it”.

Compensation measures build on the principle that soil consumption and hence the loss of soil functions (biodiversity, fertility, drainage capacity, erosion protection etc.) is compensated with restoration of soil functions somewhere else. This principle is already realised in several German Federal States through *eco accounts* and is currently tested in Austria.

Compensation measures are usually not focused on soil sealing as such, but on land take and impacts to nature in general. The costs of compensation measures seem to be very moderate with on average less than 7 €/m². A remarkable version of the *eco account* system exists in Dresden, where actual sealing is compensated by desealing measures, which average costs of 20 €/m². Although the Dresden system seems to be effective, experts from the city planning department are not sure if it will survive in the long term. With an unemployment

rate of 12 %, Saxony is under enormous economic pressure and such measures could scare potential investors away.

Trading systems. A very promising variant of the compensation system is the trading of development certificates. The logic of the system is comparable to the CO_2 emission trading mechanisms of the Kyoto Protocol. The trading of soil certificates is currently at an experimental stage and was implemented in a simulation with 14 German municipalities. Results of the simulation revealed that two land take reduction targets (-13 % and -24 % annual land take compared to 2002) were reachable.

The trading mechanism strengthens the calculation of long term planning costs and the implementation of efficient land use management practices. Key barrier to the trading system is the lack of political commitment and its complexity; the system requires the establishment of an entire market with trading mechanisms and commonly accepted rules.

5 SOIL QUALITY CRITERIA

Up to the 1990ies soil protection was not a priority in spatial planning in the EU Member States and was usually overruled by economic demands. European cities are mostly situated in river basins with the best agricultural land. Consequently growth of settlements usually results in loss of high quality land.

Many countries integrated the sustainability principle, and hence the efficient and careful use of natural resources in their spatial planning policies in the 1990ies. To which extent this principle was later on respected is described in the country profiles (see chapter 2).

About ten years ago first initiatives started to integrate soil protection and in particular the protection of soil functions in spatial planning decisions. Key objective of these initiatives were to ensure that the best soils are conserved and that alternative solutions, i.e. in areas with less valuable soil functions, are selected for new developments or that new developments are designed in a way that impacts to soil functions are reduced.

5.1 Urban Soil Evaluation in City Regions

At European level the project TUSEC-IP[109] (see also chapter 6.2) can be considered as pioneer initiative, which paved the way for sustainable planning in particular in ecologically sensitive areas, which are subject to heavy use and where there is continuous demand for building and development land – like in most European agglomerations. The project triggered the realisation of soil assessment in spatial planning, as this was the case for the municipality of Bozen and the province Upper Austria.

The project TUSEC-IP developed a procedure for soil evaluation based on soil functions. It permits soil evaluation regardless of national regulations for handling soils and is not specific to one certain pedologic method [142].

Methodology. The results of soil evaluation contribute to ensuring that in future greater consideration is given to precautionary soil protection in regional and municipal planning procedures and in the associated environmental impact assessment. There are 2 methods of evaluation.

- The A-method (scale from 1: 10.000 to 1:1000) for the mandatory planning level, needs detailed soil data (soil mapping)
- The B-method (scale 1:25.000 and less detailed) needs less detailed data for which existing data sources are usually adequate.

The evaluation procedures for A- and B- level are based on connection procedures which rely mainly on primary soil parameters. From these primary soil parameters (e.g. humus content), complex soil parameters (e.g. water retention capacity) are derived on the basis of widely introduced statistical methods. This is supplemented by climatic and hydrological parameters as well as by information about land use and levels of contamination. Respected soil functions are:

- Habitat and gene pool

[109] Technique of Urban Soil Evaluation in City Regions – Implementation in Planning Procedures. Project of the Programme Interreg IIIB Alpine Space Project

- Storing, filtering and transformation
- Food and other biomass production
- Physical and cultural environment for mankind

The result of each evaluation procedure is given as a five stage classification from “very high” to “very low”.

Application. The soil evaluation system was tested on the basis of example cases encountered in planning processes in Austria, Switzerland, Germany, Italy, and Slovenia. Tab. 15 provides a summary of planning recommendations that were produced along the text implementations in pilot areas.

Tab. 15 Selected planning recommendations from case studies
Source: TUSEC-IP [142]

Pilot area	TUSEC-IP planning recommendations
Munich (DE) Location: City boarders Size: 2 ha Planned land use: Housing and ecological areas	Special protection of the Northern and Eastern part of the area; in particular preservation of the vegetation, reduction of top soil removal to a minimum
City of Brunico (IT) Location: Entire municipal territory Size: 2,800 ha Planned land use: Evaluation of sealing classes for the entire territory	Sealing classes were allocated to the types of land use prevalent in the area, representing the differently pronounced anthropogenic influence on the soil. In order to assess past anthropogenic influence on the soil over and beyond the current use, additional data about the historical use of the test area are also evaluated.
Village Ottensheim (AT) Location: River bank area Size: 5 ha Planned land use: Conversion to sports grounds including an open air swimming pool	Due to the latent flooding risk soil sealing shall be reduced to a minimum
City of Wörgl (AT) Location: Agricultural land at the western end of the city boarders Size: 40 ha Planned land use: Commercial park	Best agricultural land of the municipality , keep the Western part of the area free of buildings
City of Grugliasco (IT) Location: Incinerator area Size: 3.5 ha Planned land use: Industrial plant	The concentrations of heavy metals in the area exceed the legislation limits of the Piemonte region. The risk for human health is high to very high when the area is used for agricultural purposes. The risk is lower when the soil is used as residential or to open green space area. The lowest HHR is when the soil land is converted to the industrial area.
City of Maribor (SI) Location: Agricultural land at the city boarders Size: 10 ha Planned land use: Housing with open	Soil quality of the area was assessed to be sufficient for housing, since the area is not a special water protection area, not a Natura 2000-area, nor a contaminated site, it has a low humus content and a high silt content at all depths

green space

Conclusions. The TUSEC – IP system was developed to meet the needs of municipalities in the Alpine Space. However, the fundamental principles of soil evaluation are not restricted to Alpine soils only. Adapting the evaluation technique to the requirements, natural circumstances and planning objectives of other city regions within and also outside the Alpine Space is possible.

There is neither a political agreement for implementing the project results nor a change in legislation that obliges local or regional authorities to use the TUSEC –IP soil evaluation technique.

The A-level technique reached a nearly perfect degree of development and can be applied in planning procedures. The B-level method needs further development and optimization.

5.2 Soil function evaluation in spatial planning (Hamburg)

In 2003 the method *Large Scale evaluation of soil functions for soils in Hamburg* was developed for the city of Hamburg in order to evaluate soils based on their functions.

Methodology. Each of the following soil parameters is evaluated separately: Habitat for humans, animals, plants and soil organisms, water and nutrient cycle, function as filter, puffer and transformer, archive function, location for agricultural and forested land. The nearer to nature a soil is classified, the more valuable it is. On the basis of the individual evaluation of the soil functions, a total evaluation is made, that again is the starting point for a prognosis evaluation. Based on the difference between the actual state and the prognosis-evaluation the extent of compensation measures can be determined [143].

Application: The method is operational since 2003.

Conclusions. Since implementation of the method good results were achieved according to the city planning. Soil protection is gaining more and more importance in planning decisions. Only recently was the building permit for a logistic centre completely revised; the built-up surface had to be reduced to 50 % because the assessment of soil functions revealed that the planned area included highly valuable soils.

The Hamburg methodology of evaluating soil functions was already revised and adopted several times since its first draft, which was developed in 1999. A new aspect that will be considered soon is the adoption of soils to climate change.

5.3 Integration of soil protection in spatial planning (Salzburg)

For various planning and construction processes an assessment of the effects upon soil is a legal requirement in the province Salzburg. In March 2010 a guideline was developed creating a uniform methodology for the assessment of soil functions in the context of planning- and approval procedures in Salzburg [144]. Legal basis of this guideline is the law for soil protection of Salzburg, the soil protection protocol of the alpine convention, as well as the EU directives on environmental impact assessment (EIA) and strategic environment assessment (SEA).

In order to assess soil functions there are two different data sets available in Austria which cover the agricultural areas all over the country, 1/ the Austrian soil map eBOD (1:25.000 – 1:50.000), 2/ Land evaluation (FBS) (1:2.000).

The soil functions: “biotope”, “habitat”, “production”, ”regulation”, “puffer” and “archive” are described and for each soil function their compliance is derived.

Application: As of autumn 2010, 2 pilot studies were carried out

Conclusions: The application of this guideline makes it possible to

- compare the impacts upon soil within the framework of alternative assessments,
- assess the effects of the planning case upon soil, and
- determine relevant measures to prevent, reduce and adjust considerable impacts upon the soil, required for a positive assessment.

5.4 Assessment of natural soils functions (Bavaria)

In 2003 the Bavarian Environment Agency published a guideline for the consideration of soil functions in spatial planning with the title “*Soil Protection as priority in spatial planning. Assessment of natural soil functions and realisation of planning and permits*”. The guideline has to be respected in all spatial planning and permit procedures [145].

The guidance document requires detailed description of soil functions and determination and evaluation of their relevance with regard to possible damages. The following levels are distinguished:

- Regional scale of greater preparative planning (scale about 1: 100.000 – 1:25.000), e.g. regional planning procedures
- Local scale of preparative planning (scale about 1: 5.000 – 1: 10.000); e.g. environmental compatibility assessment, land consolidation planning
- Local scale of mandatory planning (scale > 1: 5.000); e.g. urbanistic remediation and development measures

For each scale methods of how to evaluate the natural soil functions, the archive function of soil and threats to soil were established. The evaluation procedures for the soil functions lead to a classification in 3 to 5 levels from very low to very high depending on how far the soil function is fulfilled. From these levels the need for soil protection can be deducted.

Methodology. This methodology includes two parts

Part 1 describes the common planning and approval procedures in which soil protection is of importance. It is presented how soil can be treated applying these procedures and the soil functions that are of special interest:

- Natural soil functions; i.e. habitat for natural vegetation and for soil organisms, retention capacity for precipitation, for water soluble substances (e.g. nitrate) and for heavy metals, buffer-, filter- and transformer-capacity for organic contaminants, natural productivity of agricultural and forest land,
- Archive functions of soil
- Soil threats (e.g. erosion)

Part 2 explains the methods which are recommended in the first. It is pointed out that the individual case has to be evaluated by experts.

Conclusions: Guidance document of how the subject of soil protection is to be treated in planning and administrative decisions. The document also comprises scientifically founded methods for the acquisition and evaluation of the soil´s productivity. The document is a tool

that describes the methods to evaluate natural soil functions, the archive-function and the threats to soil in Bavaria. It explains the required parameters and describes the evaluation procedure.

5.5 Summary

The integration of soil protection and hence protection of soil functions in spatial planning is relatively new and is a result of a general commitment to sustainable spatial planning.

Several regions have established binding guidelines to consider the protection of soil functions at the level of strategic spatial planning (i.e. revision of regional land use plans, strategic planning of large developments).

At the international level the project TUSEC-IP established criteria how to respect soil functions in spatial planning. The project results are increasingly influencing spatial planning standards, as this is the case in Germany, North-Italy and Austria.

Legally binding guidelines to respect soil functions in spatial planning procedures exist in all German Federal States and will be introduced in two Austrian Provinces at the end of the year. The autonomous community Bolzano stipulates a legally binding “soil sealing index” for new developments. The Bolzano method calculates site specific soil indices based on soil functions.

Awareness of soil functions and how to respect them in spatial planning is increasingly growing. Soil functions and the implementation of mitigation measures are new aspects under the condition of global warming, currently subjects of numerous research projects.

6 NETWORKS

This chapter refers to networks and research projects dealing with the various aspects of reducing or mitigating the effects of soil sealing. All identified communities, networks or research projects address the reduction of soil sealing either indirectly or as one of several aspects but not exclusively. The chapter distinguishes between

- international communities and networks,
- international research projects, and
- funding programmes

In Fig. 83 an overall picture of all identified networks and communities and their thematic focus is presented.

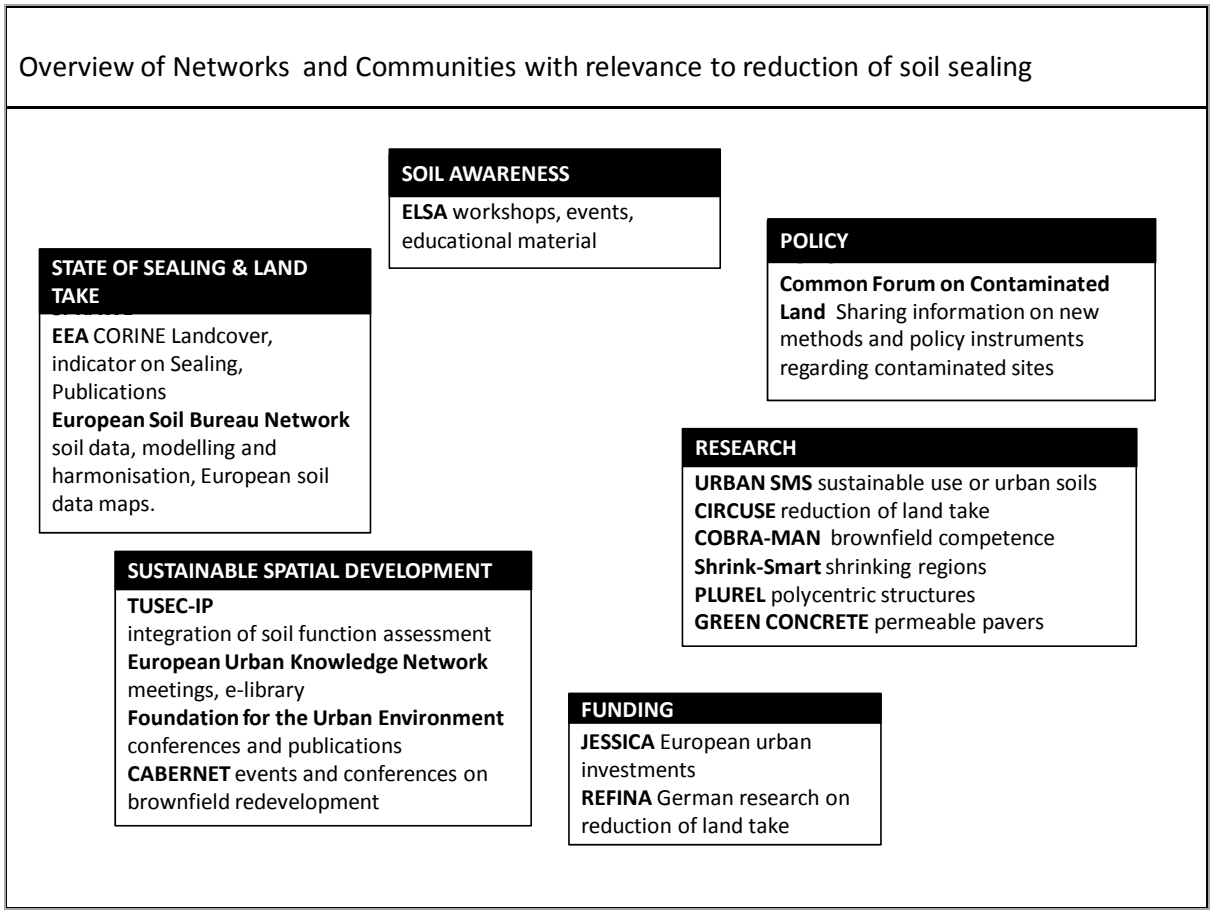


Fig. 83 Overview of networks and communities with relevance to reduction of soil sealing and land take.

6.1 International Communities and Networks

So far seven international communities and networks with relevance to soil sealing were identified. Tab. 16 provides an overview of the thematic focus and the relevance to soil sealing. The *European Topic Centre on Land Use and Spatial Information* is definitely the most important network with regard to collecting information on the state of soil sealing. With regard to sustainable urban development the *European Urban Knowledge network* and the

Foundation for the Urban Environment are relevant networks informing about new and innovative developments in the Member States.

Tab. 16 Identified international networks and communities with relevance to soil sealing.

Name	Focus	Relevance	What are they doing?
ELSA European Land and Soil Alliance (ELSA) http://www.soil-alliance.org/ Language: German (English) Members: Cities and communities Geographic coverage: Mainly German speaking countries	**Soil Awareness** Overall objective is sustainable soil use. Soil protection, to conserve soil functions all over Europe and to create awareness concerning the soil functions and their value	ELSA has a special action line for the reduction of land take and to create awareness concerning the negative effects of soil sealing and land take and informing about alternatives Target groups are pupils and the general public	Free material for schools and workshops Events and workshops
European Urban Knowledge Network http://www.eukn.org/eukn/ Language: English Members: Seventeen EU Member States, EUROCITIES, the URBACT Programme, and the European Commission Geographic coverage: EU and beyond	**Urban development** Sharing knowledge and experience on tackling urban issues.	The network tackles all urban development issues. Urban sprawl and land use are among these. The network includes an extensive e-library, containing a great number of recent publications and papers: case studies on brownfield redevelopment and inner urban development can, and scientific papers on innovative urban development tools	Organisation of meetings Maintenance of an e-library
European Soil Bureau Network http://eusoils.jrc.ec.europa.eu/esbn/ Members: Scientific Organisations from all EU Member States and beyond Language: English	**Soil data/information** Co-operation of national soil science institutions. Main tasks are to collect, harmonise, organise and distribute soil information for Europe	The European Soil Data Centre (ESDAC) is developing advanced modelling techniques and scenario analyses to provide soil information to end users in relation to major soil threats (including sealing)	Information on research projects with focus on soil data, modelling and harmonisation European soil data maps.
ETC LUSI European Topic Centre on Land Use and Spatial Information http://etc-lusi.eionet.europa.eu/ Language: English Members: Public organisations	State of soil sealing Threats to soil and their state in Europe	Regular Publication of the State of the Environment Report (land use and sealing are included) CORINE land Cover Surveys Publication of Soil Sealing Indicator	Thematic Publications Publication of indicators

Name	Focus	Relevance	What are they doing?
Geographic coverage: Europe (EU and beyond)		Thematically related publications	
Common Forum on Contaminated Land http://www.commonforum.eu/ Language: English Members: Ministries and public agencies Geographic coverage: Europe (EU + Switzerland & Norway)	Contaminated land policy Exchange of policy developments among Member States	Brownfield redevelopment is considered as an "emerging issue" and receives more and more attention.	Statements on EU policy related contaminated sites Sharing information on new methods and policy instruments regarding contaminated sites
CABERNET Concerted Action on Brownfield and Economic Regeneration Network http://www.cabernet.org.uk Members: Developers, researchers, funding organisations, and policy makers Geographic coverage: EU Language: English	Brownfield redevelopment Rehabilitation of brownfield sites within the context of sustainable development.	The redevelopment of brownfield land is a central element of sustainable spatial planning	Events and conferences on brownfield redevelopment
Foundation for the Urban Environment http://www.ffue.org/ Language: English + multilingual Members: Urban planners Geographic coverage: International	Sustainable urban development The Foundation supports and organises events and publications related to urban and environmental planning and sustainable mobility.	Giving inner urban developments priority and avoiding new "green field" developments is a key principle of sustainable urban development	Conferences and publications

6.2 International research projects

Six international research projects were identified with different relevant approaches to reducing soil sealing and land take. Of the identified projects only one refers to technology development, namely the project GREEN CONCRETE, which focused on permeable, green surfaces.

Tab. 17 Identified international research projects

Name	Focus, Objectives, Target Groups	Key Output
GREEN CONCRETE http://www.greenconcrete.eu/e_index.htm Type: FP6 / CRAFT Duration: 2006-2009 Partners: Research, medium sized companies of the building industry Involved countries: AT, DE, IT	Focus: Permeable pavers Objectives: investigate the suitability of recycling materials for the construction of gravel turf Target groups: Planners, building industry, public organisations (→ public tendering)	1/ Improvement of the gravel turf technology for higher frequented applications, like public parking space (several pilot applications). 2/ Production of standard criteria catalogues for public tendering
URBAN SMS – Urban Soil management Strategy http://www.urban-sms.eu/ Type: European Transnational Cooperation / Central Europe Duration: 2009-2012 Partners: City planning & research Involved countries: AT, DE, IT, CZ, SI	Focus: Urban Soil Protection Objectives: 1/ define, design and develop useful soil management strategies, applicable to urban planning, 2/ educate and raise awareness among the responsible decision makers. Target groups: Planners, decision makers.	Expected outputs: 1/ IT tool for urban planning for soil evaluation 2/ handbook for municipal decision makers, practical advice for soil protection within urban planning 3/ Pilot action case study book, overview of successful implementation 4/ Communication Package for public awareness, including a film
COBRA-MAN - Manager Coordinating Brownfield Redevelopment Activities http://www.cobraman-ce.eu/ Type: European Transnational Cooperation / / Central Europe Duration: 2009-2012 Partners: City planning & research Involved countries: DE, PL, CZ, IT, SI	Focus: Brownfield competence Objectives: 1/ to establish the new job profile "brownfield manager", who shall facilitate and steer brownfield revitalisation processes Target groups: Planners, decision makers, students.	Expected outputs: 1/ Master study programme for a new qualification in the management of the brownfield redevelopment 2/ Pilot applications in 7 pilot regions

Name	Focus, Objectives, Target Groups	Key Output
CIRCUSE - Circular flow land use management Type: European Transnational Cooperation / / Central Europe Duration: 2010-2013 Partners: City planning & research Involved countries: AT, DE, PL, CZ, SK, IT,	Focus: Reduction of land take in spatial planning Objectives: 1/ To implement the principle for circular land use, to reduce land take and improve land use efficiency Target groups: Planners, decision makers in municipalities, pupils and students	Expected outputs: 1/ Five pilot applications for circular land use management 2/ Management structures for circular land use management
SHRINK-SMART - The Governance of Shrinkage within a European Context http://www.shrinksmart.ufz.de/ Type: FP7. Duration: 2009 - 2012 Partners: Universities. Involved countries: DE, IT, PL, RO, UK, Ukraine	Focus: Shrinking regions Objectives: 1/ To understand the process of shrinking based on 7 case studies, including include Leipzig / Halle (DE) , Liverpool (UK), Ostrava (CZ), the Upper Silesian Industrial District (PL), Timisoara (RO), Greater Donetsk (Ukraine), Genoa (IT) Target groups: urban planners	Expected outputs: 1/ The project aim to provide answers to three overarching questions and working hypothesis 2/ Production of strategies, tools and instruments to mitigate the negative effects of shrinking
TUSEC-IP – Soils in City Regions. Procedures and Strategies for a sustainable spatial development http://www.tusec-ip.org/ Type: Interreg IIIB Duration: 2003-2006 Partners: Universities, Municipalities, Cities, Envir.Agency Austria, Province of Bolzano Involved countries: DE, IT, AT, Slovenia, CH	Focus: Soils in city regions Objectives: 1/ Reduction of soil and land take and of soil pollution 2/ harmonisation of handling with soil in planning procedures in Alpine Space 3/ enhancement of the significance of soil protection in local acting 4/promotion of transnational exchange of experience and knowledge 5/support of a sustainable further development of economy, trade and commerce in Alpine Space Target groups: municipal planners	1/A compilation of the legal principles in the participating countries on national, regional and local level 2/ a list with the requirements on the technique of soil evaluation 3/a procedure for evaluating soil functions and soil degradation 4/ a manual describing the application of the soil evaluation technique to different planning procedures and as a planning tool
PLUREL- Peri-urban Land Use Relationships - Strategies and Sustainability Assessment Tools for Urban-Rural Linkages http://www.plurel.net/ Type: FP6. Duration: 2007 - 2010 Partners: research organisation and public agencies Involved countries: AT, DE, DK, FI, FR, GR, HU, IRL, NL, PL, SI, UK	Focus: Polycentric structures Objectives: 1/ to develop new strategies and planning and forecasting tools that are essential for developing sustainable rural-urban land use relationships. Target groups: regional planners	Expected outputs: Based on case studies in Warsaw, Leipzig, Den Hague, Manchester, Montpellier, and Koper: 1/ Sustainability Impact Assessment Tool for Rural Urban Regions (SIAT-RUR) 2/ Best Practice and Planning Guidance 3/ Data and Map Information Portal

The project TUSEC-IP established criteria how to respect soil functions in spatial planning. The project results are increasingly influencing spatial planning standards, as this is the case in Germany, North-Italy and Austria. The project COBRA-MAN focuses on establishing competence, and the project CIRCUSE capitalises on inner-urban development by introducing the “prevent & reuse” logic of material streams into spatial planning. The project GREEN-CONCRETE developed robust green surfaces which can be built by using recycling material in the subsurface. The surfaces have a great potential to be used at large parking areas at recreational sites but also at higher frequented sites such as super-markets and rail-way stations. Another relevant aspect is the matter of shrinking regions. Uncontrolled development in rural regions and empty villages with very little infrastructure is a phenomenon that affects all rural regions in Europe and can be considered as a significant pace maker for increasing land take and sealing despite of decreasing population. The projects SHRINK-SMART and PLUREL are dedicated to sustainable development in rural regions by respecting the conservation of soil resources.

6.3 Funding Programmes

So far two funding programmes (Tab. 18) for the reduction of land take and urban sprawl were identified. The German REFINA network - the title can be translated with "*Research for the Reduction of Land Consumption and for Sustainable Land Management*" is currently the largest and most extensive funding programme in this respect. REFINA focuses on two key objectives: (1) the reduction of daily land take to 30 hectares per day and (2) to give priority to developments within settlements despite of developments outside settlements (a ratio of 3 developments inside per 1 development outside is envisaged). REFINA is long term research programme supposed to run until 2020. Key products are guidelines and tools for all relevant stakeholders and all relevant sectors, key thematic action lines are

- Assessing regional land reuse potentials (target group are planning authorities),
- Assess economic risks and benefits of land development[110] (target group are municipalities)
- Awareness raising (pupils, the public en large)
- Decision support tools (policy makers)
- Assessment of soil quality and soil functions (planners)

In summer 2010 more than 40 guidelines and applications tools were published. Furthermore, new methodologies are being developed and tested in pilot regions. One of the most discussed topics is the introduction of tradable certificates for land use (see also chapter compensation methods).

The second remarkable programme is called JESSICA and is part of the European Structural Funds. JESSICA’s overall aim is to promote inner urban development and has a strong focus on brownfield redevelopment.

110 In practice only the short term costs of land developments are considered, since new business settlements and new inhabitants provide new income for municipalities. Apart from these incomes municipalities also have costs for the provision and maintenance of infrastructure (streets, public services, sewage system, etc.). These costs are usually higher for developments outside than for inner urban development.

Tab. 18 Funding programmes

Name	Focus & Target groups	Output
REFINA Forschung für die Reduzierung der Flächeninanspruchnahme und ein nachhaltiges Flächenmanagement[111] http://www.refina-info.de/en Duration: 2007 - 2020	Focus: 1/ reduction of daily land take in Germany 2/ to give priority to inner urban developments Target Groups: decision makers at municipalities, planning authorities, the public	More than 11 research projects 40 guidelines and applications tools were published. New methodologies are being developed and tested in pilot regions.
JESSICA Sustainable development for urban areas http://ec.europa.eu/regional_policy/funds/2007/jjj/jessica_en.htm	Focus: promotion of sustainable investment, growth and jobs in Europe´s urban Target Groups: public, municipal or private sector enterprises	By mid-May 2009 36 studies were launched, 16 completed and 9 published.

6.4 Summary

At the level of international networks only very few aspects of the issue soil sealing are currently covered: monitoring, exchange of knowledge and raising awareness are partly covered but there are no international initiatives with the objective to push the issue on the EU political agenda.

Apart from the European Structural Funds, who have currently an action line for brownfield recycling, there are hardly any funding programmes which directly or indirectly address soil sealing. The German REFINA programme funds research related to land take and is for sure the largest and most remarkable research programme in this thematic field. It is therefore highly recommended to carry selected research results and text implementations forward to other countries.

With regard to international research initiatives a lot of promising work has been completed and is being currently carried out. Apart from the visible innovation of these projects they create also positive side effects which usually survive the project's duration, such as the creation of transnational thematic communities and the interest in new solutions.

There is hope that the various outputs of current international research projects, which address soil sealing, the reduction of land take or urban sprawl will create sufficient critical mass to change the state of the art of Europe's spatial planning.

111 Research for the Reduction of Land Consumption and for Sustainable Land Management

7 CONCLUSIONS & RECOMMENDATIONS

7.1 The impact of soil sealing

Soil sealing can be defined as the covering of soils by buildings, constructions and layers of completely or partly impermeable artificial material (asphalt, concrete, etc.). It is the most intense form of land take and is essentially an irreversible process. Soil sealing results in the loss of important soil functions, above all soil fertility and water storage capacity. Soil sealing is of growing concern in the European Union:

- Loss of soil fertility. In view of rising energy prices the production of food and biomass within the European Union's territory is gaining importance. As a consequence the demand for productive soils is growing.
- Increasing flood risk. It is an emerging issue which can best be mitigated by conserving the water storage capacity of soils, either directly (limiting sealing) or indirectly (e.g. through green roofs).
- Impacts from urban sprawl. Urban sprawl is the most common form of land take and is understood as a low-density expansion of urban areas into the surrounding agricultural areas leading to an increase in traffic and air emissions, infrastructure costs for the municipality concerned and in many cases also in the loss of high-quality agricultural land.

7.2 State and trend of land take and soil sealing in EU 27

In 2006 the European Union's main land bears a sealing rate of 2.3 % with an increasing trend. Whereas some Member States are hardly affected by soil sealing on a national scale, others have large parts of their territories concerned, above all Cyprus, Belgium, Germany, Luxembourg, Malta, and the Netherlands. At the regional level all regions along the Mediterranean coast, most other coastal regions, and almost all large urban agglomerations are affected by soil sealing.

Since the turn of the century a slight decrease of annual land take can be observed in the European Union but it has to be noted that population growth has also been slowing down in the same period. A decoupling of population growth and land take has hence not been achieved.

A noteworthy positive trend is the fact that the European Regional Development Funds has earmarked 21.1 billion Euro for urban development for the funding period 2007 – 2013, specifically dedicated to the rehabilitation of urban brownfield sites, regeneration of run down districts, clean urban transport, and urban housing projects. All these measures can reduce land take on greenfields, thus contributing to limiting sealing.

7.3 Key recommendations

Efficient protection of soils from further sealing can only be achieved by following an integrated approach, requiring the full commitment of all governmental units (and not only those dealing with spatial planning and environment), by improving awareness and competence within all concerned stakeholders, by freezing counterproductive policies (i.e. funding of single family houses at urban fringes, commuter bonus etc.), by establishing clear financial incentives, and by introducing binding legal requirements. In this context a three-tiered approach based on the "prevent, limit, and compensate" principle is proposed, similar to the

logic used in waste materials streams (see Fig. 84).

Soil Sealing: Prevent – Limit – Compensate

Tier 1: Prevention of Soil Sealing.
To "pave the way" for successful prevention of soil loss the following basic principles need to be implemented at the policy level:

- to establish the principle of sustainable development in spatial planning
- to define realistic land take targets for the national and the regional level
- to integrate the "prevent, limit, and compensate" principle for soil loss in all policy sectors
- to streamline existing funding policies accordingly (i.e. public funding for private housing, subsidies for developments on the green field sites, commuter bonuses, etc.)

According to the individual regional needs the following key action lines are proposed:

- to steer new developments to already developed land
- to provide financial incentives for the development of brownfield sites
- to improve the quality of life in large urban centres
- to make small city centres more attractive to counteract dispersed settlement structures in rural regions with shrinking population
- to designate agricultural soils and valuable landscapes with development restrictions

Tier 2: Limit Soil Sealing as far as possible
Whenever soil loss is unavoidable, mitigation measures shall be implemented as far as possible, this can be realised by,

- respecting soil quality along planning processes and steering new developments towards less valuable soils
- by applying technical mitigation measures to conserve at least a few soil functions (i.e. permeable surfaces on parking areas)

Tier 3: Compensate soil losses
For specific infrastructure developments even top quality soils will be lost and valuable landscapes fragmented. In such cases controlled compensation measures shall be carried out to facilitate soil restoration measures somewhere else where they make sense. This can be achieved by,

- establishing qualified compensation measures
- facilitating new opportunities

Fig. 84 The "prevent – limit – compensate" principle for soil sealing.
Source: Umweltbundesamt, 2010

Tier 1: Prevention of soil sealing. To "pave the way" for successful prevention of soil loss

the following basic principles need to be implemented at the policy level:

- **To establish the principle of sustainable development in spatial planning** by following an integrated approach, requiring the full commitment of all governmental sectors (and not only spatial planning and environment).
  Best practice: The majority of the EU Member States has established the principle of sustainable development in their key spatial planning regulations, referring to economic use of soil resources and avoidance of unnecessary urban sprawl.
  However, without binding measures, regular monitoring and critical assessment soil functions cannot be protected adequately.
- **To define realistic land take targets at the national and the regional level**
  Best practice: Quantitative limits for annual land take exist only in six Member States, as this is the case in Austria, Belgium (Flanders), Germany, Luxembourg, the Netherlands, and the United Kingdom. In all cases the limits are indicative and are used as monitoring tools. In the United Kingdom and Germany the national targets are taken most seriously and their progress is regularly assessed. Only in the United Kingdom are development targets also defined at the regional level.
- **To streamline existing funding policies accordingly** by freezing subsidies that encourage land take and soil sealing (i.e. public subsidies for private housing on undeveloped land, subsidies for developments on the green field sites, commuter bonuses, etc.).
  Best practice: So far no examples identified.
- **To develop specific regional approaches according to the actual land use pressures.**
  - **To steer new developments to already developed land and provide financial incentives for the development of brownfield sites**
    Best practice: Initial or supportive funding to encourage new infrastructure developments on brownfield sites exists in several Member States and is usually coordinated by designated brownfield organisations. Brownfield redevelopment projects are mostly realised in the form of private public partnerships: (1) The *English Partnerships* is probably the most experienced public land developer in the European Union and provides funding for social housing developments on derelict areas; (2) France disposes of a network of more than 20 public land development agencies, which among other activities develop brownfield land for social housing; (3) The land development agencies *Czech Invest* and *Invest in Silesia* are in charge of developing major industrial brownfields for new industrial investors; (4) In Flanders specific contracts (brownfield covenants) are negotiated between the government and private investors to promote brownfield redevelopment.
  - **To improve the quality of life in large urban centres**
    Best practice: Several urban renewal programmes have been launched recently with the objective to attract new residents and create new jobs in central urban areas in decline. Best practice examples in this respect are (1) the urban renewal programmes of *Porto* and *Lisbon* and the neighbourhood renewal programme in *Catalonia* both of which are supported by the European Regional Development Funds, (2) the *Västra hamnen* project in Malmö which is built on derelict harbour premises providing 1,000 new dwellings with the lowest possible environmental impact, (3) the *Erdberger Mais* development in Vienna which is built on five inner urban brownfield areas, providing housing for 6,000 new inhabitants and 40,000 work places, (4) the *Randstad* programme in the Netherlands which puts special emphasis on improving

the attractiveness of inner urban areas in the metropolitan agglomeration of Amsterdam, Rotterdam, and Den Haag.

- **To make small city centers more attractive** in order to counteract dispersed settlement structures in rural regions with shrinking population.
  Best practice: The Danish Spatial Planning Act puts clear restrictions on the construction of large shops and shopping centers on green fields out-side the largest cities and promotes small retailers in small and medium sized towns.
- **To impose development restrictions on top agricultural soils and valuable landscapes**
  Best practice: Several Member States have established specific policies to avoid further land take and sealing on their best agricultural soils and most valuable landscapes, as this is the case (1) in Spain where building activities within the first 500 meters from the sea are strictly controlled, (2) in France and the Netherlands where designated "green and blue" landscapes are protected from infrastructure developments, (3) in the Czech Republic and Slovakia where the conversion of top agricultural soils requires a fee.

Tier 2: Limit soil sealing as far as possible. Whenever the development of built-up areas is unavoidable, mitigation measures shall be implemented as far as possible. This can be realised by:

- **Considering soil quality in planning processes and steering new developments towards less valuable soils**
  Best practice: The integration of soil protection and hence protection of soil functions in spatial planning is relatively new and is a result of a general commitment to sustainable spatial planning. Indicative guidelines to respect soil functions in spatial planning procedures exist in all German Federal States, in two Austrian Provinces, and in the autonomous province of Bolzano. Awareness of soil functions and how to respect them in spatial planning is increasingly growing.
- **Applying technical mitigation measures to conserve at least a few soil functions** (i.e. permeable surfaces on parking areas).
  Best practice: Permeable surfaces can help to conserve soil functions and mitigate the effects of soil sealing to a certain extent. They contribute to the local water drainage and storage capacity and can in some cases also fulfill biological or landscaping functions. A broad range of materials and concepts is available for permeable surfaces. In addition to their clear ecological advantages most types of surfaces have lower lifespan costs compared to conventional impermeable surfaces. With regard to sustainability most permeable surfaces are made of materials that are locally available and reusable. Most advanced in this respect is the United Kingdom, where permeable surfaces are broadly used – even in big cities – and where research and guidelines exist manifold.

Tier 3: Compensate soil loss. For specific infrastructure developments even top quality soils will be lost and valuable landscapes fragmented. This will be in particular the case along road constructions. In such cases controlled compensation measures should be carried out to facilitate soil restoration measures somewhere else where they make sense. Experience has shown that compensation should not be carried out by developers themselves but by qualified organisations.

- **To establish adequate compensation measures**
  Best practice: *Compensation fees* for the conversion of agricultural soils into building land are being charged in the Czech Republic and Slovakia. The income of the fee is

directed to an environmental fund. *Compensation measures* build on the principle that soil consumption and hence the loss of soil functions (biodiversity, fertility, drainage capacity, erosion protection etc.) is compensated with restoration of soil functions somewhere else. This principle is already realized in several German Federal States through *eco accounts* and is currently tested in Austria.

- **To facilitate new opportunities**
  A major barrier for the realisation of new green urban areas is usually the lack of financial resources. A compensation funds can facilitate new projects which were not possible beforehand. For example the conversion of an urban derelict area into a green urban area.
  Best practice: In order to confine sealed surfaces in the Dresden region and to contribute to flood prevention the city of Dresden requires that new developments on undeveloped land are compensated by de-sealing or "greening" measures somewhere else but within the city boundaries. Developers have the opportunity to carry out compensation measures by themselves or to pay a compensation fee to the Environment Authority of the City, who is in charge of several de-sealing projects.

7.4 Addressing the right policy level

At the EU level there are no binding requirements to prevent unnecessary soil loss caused by soil sealing. The impacts of soil sealing are however of European concern especially in view of raising energy prices and global warming. In particular the soil functions "water storage capacity" and "soil fertility" are of growing economic importance. It can be expected that single Member States will refrain from applying stricter regulations to protect their soils from sealing as this could represent a market disadvantage. A common agreement of all Member States to protect their soils from further unnecessary degradation is therefore of utmost importance. The Proposal for a Soil Framework Directive in 2007 represented a movement in the right direction but a future success of this endeavor is at the moment very doubtful. It is therefore recommended that the European Commission continues to raise awareness with regard to soil protection and publishes a strategic document:

- Making clear that unsustainable land use patterns and in particular progressing land take are key energy consumers,
- Demanding that the *avoid, mitigate, compensate principle for soil sealing* needs to be integrated in all sectoral policies,
- Requiring that Member States monitor land take and soil sealing,
- Asking Member States to establish suitable instruments to support the decoupling of annual land take from population growth and economic growth,
- Demanding that soil protection is promoted by the European Structural Funds and that funding objectives respect the *avoid, mitigate, compensate principle for soil sealing*, and
- Furthering that best practice for preventing soil loss is promoted via the European Territorial Co-operation Programme and the European Research Framework Programme.

The national level. The majority of the EU Member States have established the principle of sustainable development in their key spatial planning documents, referring to economic use of soil resources and avoidance of unnecessary urban sprawl. However, in order to accelerate a decrease of annual land take the following measures are recommended:

- To regularly monitor and assess annual land take and soil sealing.

- To require that regions define realistic targets for annual land take according to their growth forecasts for population and economy,
- To promote awareness how to avoid unnecessary soil sealing and provide best practice examples and guidance for all user levels; i.e. organisation of thematic conferences and workshops, best practice collections.
- To streamline national funding policies; i.e. abolish funding mechanisms that support further land take and disperse settlement structures (i.e. subsidies for commuting or housing without access to public transport).
- To provide clear financial incentives for inner urban development, ideally funded by compensation payments.
- To require that regions establish compensation systems for soil loss.
- To define regions at risk and establish specific regimes for such regions; i.e. monitoring and assessment obligation, definition of local development targets, provision of financial incentives.

The regional level. With the exception of very small Member States, spatial planning regulations are usually under the responsibility of regional planning authorities. The regional level (i.e. Autonomous Regions, Provinces, Bundesländer, Voivodships etc.) can be considered as most relevant for influencing spatial development trends. In order to reach more efficient land use and to avoid unnecessary soil sealing the following actions are recommended:

- To define specific regional targets for annual land take under full consideration of the *avoid, mitigate, compensate principle for soil sealing* and the actual future needs.
- To promote and organise training courses for policy makers at the local level and to cultivate awareness for soil functions through educational programmes at schools.
- To establish soil compensation mechanisms for soil loss.
- To make sure that regional funding schemes respect the *avoid, mitigate, compensate principle for soil sealing*.

The local level. Planning decisions together with building permits are usually issued at the local level (i.e. municipalities or city planning) with the exception of very large projects that would require the authorisation of higher level authorities. Local planning and building authorities can influence where and how new structures are built. The following actions are recommended to make sure that new projects are realised with the least possible destruction of soil functions:

- To consider soil quality along planning and consider alternative scenarios.
- To protect green areas at the fringe of settlements.
- To promote inner urban development by realizing strategic projects.
- To promote the renewal and reuse of derelict sites.
- To avoid unnecessary soil sealing as far as possible by promoting mitigation technologies.
- To prescribe sealing limits in building permits.

7.5 Key conclusions

Despite several initiatives it can be concluded that soils are not adequately protected in the European Union. Soil quality is rarely respected along planning processes and compensation of soil losses hardly realised. Economic growth is still highly depending on land take and soil

sealing.

In order to decouple economic growth from land take and soil sealing, it is suggested to strictly follow the *avoid-limit and compensate principle* for soil sealing. Several elements of this logic are already being realised in some Member States as described in the section above and in the country profiles of this report. However, limitations to soil sealing are primarily based on voluntary agreements and non binding measures.

It can be expected that single Member States will refrain from applying stricter regulations to protect their soils from sealing as this could represent a market disadvantage.

It can be concluded that binding measures to avoid and limit soil sealing as far as possible need to be established at the EU level. A common regulatory framework in particular for regions with high land use pressures can be considered as the only solution to achieve better progress with regard to a sustainable use of the European Union's soils.

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Relevant EU policy

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Technical measures to mitigate soil sealing

Consulted experts

Bernhard Scharf , University for Life Sciences, Vienna (Telephone interview: June 25, 2010).

Jürgen Preiss, City of Vienna, department for Environment Protection (Telephone interview: June 29, 2010).

Unterberger, Autonome Provinz Bozen, Abt. Raumordnung (Telephone interview: June 14, 2010).

Doris Stepputtis, Stadtplanungsamt, Landeshauptstadt Dresden (Telephone interview: July 2, 2010).

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Download: http://www.icpi.org/

Compensation sytems

Consulted experts

Dr. Jirina Jackson (IURS - Institut pro udržitelný rozvoj sídel o.s.)

J Patrick Steinmetz, Ökoagentur Hessen

Ute Ojowski, Ausgleichsagentur SH GmbH in Schleswig Holstein

Andreas Hacker, Stadt Umland Management Wien Niederösterreich

Wolfgang Socher, Landeshauptstadt Dresden, Umweltamt

Ing. Helena Bendova, Ministry of the Environment, Prague

Dr. Pavol Bielek. Soil Science and Conservation Research Institute, Slovakia

Prof. Dagmar Petrikova, University of Bratislava

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Soil quality cirteria

Consulted experts

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Language(s): en
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Language(s): en
http://etc-lusi.eionet.europa.eu/

Common Forum on Contaminated Land
Language(s): en
http://www.commonforum.eu/

CABERNET Concerted Action on Brownfield and Economic Regeneration Network
Language(s): en
http://www.cabernet.org.uk

Foundation for the Urban Environment
Language(s): en, multilingual
http://www.ffue.org/

URBAN SMS – Urban Soil management Strategy
Language(s): en
http://www.urban-sms.eu/

COBRA-MAN - Manager Coordinating Brownfield Redevelopment Activities
Language(s): en
http://www.cobraman-ce.eu/

SHRINK-SMART - The Governance of Shrinkage within a European Context
Language(s): en
http://www.shrinksmart.ufz.de/

TUSEC-IP – Soils in City Regions. Procedures and Strategies for a sustainable spatial development
Language(s): en
http://www.tusec-ip.org/

PLUREL- Peri-urban Land Use Relationships - Strategies and Sustainability Assessment Tools for Urban-Rural Linkages
Language(s): en
http://www.plurel.net

REFINA Forschung für die Reduzierung der Flächeninanspruchnahme und ein nachhaltiges Flächenmanagement (*translation: Research for the Reduction of Land Consumption and for Sustainable Land Management*)
Language(s): de
http://www.refina-info.de/en

JESSICA Sustainable development for urban areas
Language(s): en
http://ec.europa.eu/regional_policy/funds/2007/jjj/jessica_en.htm

ANNEX

The following tables include core data sets used for the country assessments in Chapter 1 and 2. The sources are listed below.

Artificial Surface

CORINE Land Cover (CLC) data are raster data and can be obtained from the Website of the European Environment Agency

- http://www.eea.europa.eu/data-and-maps

The size of the minimum mapping unit is 25 hectares with a minimum width of 100 meters. Land cover changes of up to 5 ha are considered.

Data sets are available for the years 1990, 2000, and 2006. For the assessment the category "artificial surfaces" was used, including the following subcategories:

CLC Code	Label 2	Label 3
111	Urban fabric	Continuous urban fabric
112	Urban fabric	Discontinuous urban fabric
121	Industrial, commercial & transport units	Industrial or commercial units
122	Industrial, commercial & transport units	Road & rail networks & associated land
123	Industrial, commercial & transport units	Port areas
124	Industrial, commercial & transport units	Airports
131	Mine, dump & construction sites	Mineral extraction sites
132	Mine, dump & construction sites	Dump sites
133	Mine, dump & construction sites	Construction sites
141	Artificial, &-agric. vegetated areas	Green urban areas
142	Artificial, &-agric. vegetated areas	Sport and leisure facilities

- Values for CLC1990 were updated by values published in EEA Report No. 11 "Land Accounts for Europe". The update was made due to the fact that the actual time span between the production of CLC1990 data and CLC 2000 varied between 5 and 15 years.
- Missing data were replaced by estimates in order to derive EU summary values:
    - Estimates for CLC 1990 for Cyprus, Finland, Malta, and Sweden assume an average yearly land take of 2.1 m² per capita.
    - Estimates for CLC 2006 for Greece assume an average yearly land take of 2 m² per capita and for the UK 0.6 m² per capita.

Sealed Surface

Data on Soil Sealing are available as raster data sets with a resolution of 20 x 20m within a cell of 100 m x 100 m and can be obtained from the Website of the European Environment Agency.

- http://www.eea.europa.eu/data-and-maps/data/eea-fast-track-service-precursor-on-land-monitoring-degree-of-soil-sealing-100m-1/

Data refer to the year 2006 and are available for all EU Member States.

Population

Population data for the years 1990, 2000, and 2006 were obtained from the EUROSTAT data base:

- http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Country Name	Total Surface [hectare]	Artificial Surface CLC 1990 [hectare]	Artificial Surface CLC 2000 [hectare]	Artificial Surface CLC 2006 [hectare]	Sealed Area, EEA layer 2006 [hectare]	Population 1990 EUROSTAT [capita]	Population 2000 EUROSTAT [capita]	Population 2006 EUROSTAT [capita]
Austria	8,392,463	392,958	401,408	409,181	160,885	7,664,800	8,002,186	8,254,298
Belgium	3,066,430	605,485	627,595	630,347	225,947	9,947,800	10,239,085	10,511,382
Bulgaria	11,096,372	549,815	553,385	557,529	203,639	8,767,300	8,190,876	7,718,750
Cyprus	925,971	67,544	68,870	79,103	33,491	572,700	690,497	766,414
Czech Republic	7,886,893	472,803	493,223	501,899	251,459	10,362,100	10,278,098	10,251,079
Denmark	4,289,089	301,465	315,255	324,745	152,492	5,135,400	5,330,020	5,427,459
Estonia	4,346,186	86,603	90,953	94,173	39,399	1,570,600	1,372,071	1,344,684
Finland	33,702,920	461,581	472,234	483,422	198,390	4,974,400	5,171,302	5,255,580
France	54,881,341	2,588,183	2,744,303	2,826,586	1,521,782	56,577,000	60,545,022	63,229,443
Germany	35,708,592	2,744,401	2,964,561	3,012,304	1,814,990	79,112,800	82,163,475	82,437,995
Greece	13,162,924	231,604	270,084	283,301	177,111	10,120,900	10,903,757	11,125,179
Hungary	9,300,074	532,595	546,685	561,572	294,115	10,374,800	10,221,644	10,076,581
Ireland	6,987,857	108,416	142,516	162,565	111,301	3,507,000	3,777,763	4,209,019
Italy	30,150,499	1,362,772	1,450,012	1,498,303	846,941	56,694,400	56,923,524	58,751,711
Latvia	6,461,353	85,011	85,241	86,224	72,005	2,668,100	2,381,715	2,294,590
Lithuania	6,497,798	209,948	212,818	215,648	131,341	3,693,700	3,512,074	3,403,284
Luxembourg	259,741	22,303	24,003	24,171	12,735	379,300	433,600	469,086
Malta	31,586	7,402	8,171	8,178	4,112	352,400	380,201	405,006
Netherlands	3,735,750	406,803	475,143	510,995	304,163	14,892,600	15,863,950	16,334,210
Poland	31,195,005	1,211,876	1,243,546	1,254,749	738,002	38,038,400	38,653,559	38,157,055
Portugal	9,196,404	237,586	287,976	315,507	285,121	9,996,000	10,195,014	10,569,592
Romania	23,845,069	1,490,431	1,502,611	1,511,699	382,830	23,211,400	22,455,485	21,610,213
Slovakia	4,901,397	257,984	265,604	268,718	115,374	5,287,700	5,398,657	5,389,180
Slovenia	2,027,724	53,795	55,155	56,215	37,247	1,996,400	1,987,755	2,003,358
Spain	50,672,957	759,205	893,455	1,030,762	718,503	38,826,300	40,049,708	43,758,250
Sweden	44,911,418	593,125	611,383	628,929	196,018	8,527,000	8,861,426	9,047,752
UK	24,446,664	1,773,010	1,814,910	1,836,368	829,377	57,157,000	58,785,246	60,425,786
EU27	**432,080,477**	**17,614,704**	**18,621,100**	**19,173,193**	**9,858,768**	**470,408,300**	**482,767,710**	**493,226,936**

Note: Figures with black back ground are estimates based on the calculation explained on page 223.

Country Name	Share of Artificial Surface 1990 [%]	Share of Artificial Surface 2000 [%]	Share of Artificial Surface 2006 [%]	Sealed Surface per total surface [%]	Sealed Surface per Artificial [%]	Artificial Surface per capita 1990 [m²/cap]	Artificial Surface per capita 2000 [m²/cap]	Artificial Surface per capita 2006 [m²/cap]
Austria	4.7%	4.8%	4.9%	1.9%	39.3%	513	502	496
Belgium	19.7%	20.5%	20.6%	7.4%	35.8%	609	613	600
Bulgaria	5.0%	5.0%	5.0%	1.8%	36.5%	627	676	722
Cyprus	7.3%	7.4%	8.5%	3.6%	42.3%	1,179	997	1032
Czech Republic	6.0%	6.3%	6.4%	3.2%	50.1%	456	480	490
Denmark	7.0%	7.4%	7.6%	3.6%	47.0%	587	591	598
Estonia	2.0%	2.1%	2.2%	0.9%	41.8%	551	663	700
Finland	1.4%	1.4%	1.4%	0.6%	41.0%	928	913	920
France	4.7%	5.0%	5.2%	2.8%	53.8%	457	453	447
Germany	7.7%	8.3%	8.4%	5.1%	60.3%	347	361	365
Greece	1.8%	2.1%	2.2%	1.3%	62.5%	229	248	255
Hungary	5.7%	5.9%	6.0%	3.2%	52.4%	513	535	557
Ireland	1.6%	2.0%	2.3%	1.6%	68.5%	309	377	386
Italy	4.5%	4.8%	5.0%	2.8%	56.5%	240	255	255
Latvia	1.3%	1.3%	1.3%	1.1%	83.5%	319	358	376
Lithuania	3.2%	3.3%	3.3%	2.0%	60.9%	568	606	634
Luxembourg	8.6%	9.2%	9.3%	4.9%	52.7%	588	554	515
Malta	23.4%	25.9%	25.9%	13.0%	50.3%	210	215	202
Netherlands	10.9%	12.7%	13.7%	8.1%	59.5%	273	300	313
Poland	3.9%	4.0%	4.0%	2.4%	58.8%	319	322	329
Portugal	2.6%	3.1%	3.4%	3.1%	90.4%	238	282	299
Romania	6.3%	6.3%	6.3%	1.6%	25.3%	642	669	700
Slovakia	5.3%	5.4%	5.5%	2.4%	42.9%	488	492	499
Slovenia	2.7%	2.7%	2.8%	1.8%	66.3%	269	277	281
Spain	1.5%	1.8%	2.0%	1.4%	69.7%	196	223	236
Sweden	1.3%	1.4%	1.4%	0.4%	31.2%	696	690	695
UK	7.3%	7.4%	7.5%	3.4%	45.2%	310	309	304
EU27	**4.1%**	**4.3%**	**4.4%**	**2.3%**	**51.4%**	**374**	**386**	**389**

Note: Figures with black back ground are estimates based on the calculation explained on page 223.

Country Name	Sealed Surface per capita 2006 [m²/cap]	Artificial Surface Growth 1990 - 2000 [%]	Artificial Surface Growth 2000 - 2006 [%]	Artificial Surface Growth 1990 - 2006 [%]	Population Growth 1990 - 2000 [%]	Population Growth 2000 - 2006 [%]	Population Growth 1990 - 2006 [%]	Population Density 2006 [cap/km²]
Austria	195	2.2%	1.9%	4.1%	4.4%	3.2%	7.7%	98
Belgium	215	3.7%	0.4%	4.1%	2.9%	2.7%	5.7%	343
Bulgaria	264	0.6%	0.7%	1.4%	-6.6%	-5.8%	-12.0%	70
Cyprus	437	2.0%	14.9%	17.1%	20.6%	11.0%	33.8%	83
Czech Republic	245	4.3%	1.8%	6.2%	-0.8%	-0.3%	-1.1%	130
Denmark	281	4.6%	3.0%	7.7%	3.8%	1.8%	5.7%	127
Estonia	293	5.0%	3.5%	8.7%	-12.6%	-2.0%	-14.4%	31
Finland	377	2.3%	2.4%	4.7%	4.0%	1.6%	5.7%	16
France	241	6.0%	3.0%	9.2%	7.0%	4.4%	11.8%	115
Germany	220	8.0%	1.6%	9.8%	3.9%	0.3%	4.2%	231
Greece	159	16.6%	4.9%	22.3%	7.7%	2.0%	9.9%	85
Hungary	292	2.6%	2.7%	5.4%	-1.5%	-1.4%	-2.9%	108
Ireland	264	31.5%	14.1%	49.9%	7.7%	11.4%	20.0%	60
Italy	144	6.4%	3.3%	9.9%	0.4%	3.2%	3.6%	195
Latvia	314	0.3%	1.2%	1.4%	-10.7%	-3.7%	-14.0%	36
Lithuania	386	1.4%	1.3%	2.7%	-4.9%	-3.1%	-7.9%	52
Luxembourg	271	7.6%	0.7%	8.4%	14.3%	8.2%	23.7%	181
Malta	102	10.4%	0.1%	10.5%	7.9%	6.5%	14.9%	1,282
Netherlands	186	16.8%	7.5%	25.6%	6.5%	3.0%	9.7%	437
Poland	193	2.6%	0.9%	3.5%	1.6%	-1.3%	0.3%	122
Portugal	270	21.2%	9.6%	32.8%	2.0%	3.7%	5.7%	115
Romania	177	0.8%	0.6%	1.4%	-3.3%	-3.8%	-6.9%	91
Slovakia	214	3.0%	1.2%	4.2%	2.1%	-0.2%	1.9%	110
Slovenia	186	2.5%	1.9%	4.5%	-0.4%	0.8%	0.3%	99
Spain	164	17.7%	15.4%	35.8%	3.2%	9.3%	12.7%	86
Sweden	217	3.1%	2.9%	6.0%	3.9%	2.1%	6.1%	20
UK	137	2.4%	1.2%	3.6%	2.8%	2.8%	5.7%	247
EU27	**200**	**5.7%**	**3.0%**	**8.8%**	**2.6%**	**2.2%**	**4.9%**	114

Note: Figures with black back ground are estimates based on the calculation explained on page 223.

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