EEA Report | No 2/2008

Effectiveness of environmental taxes and charges for managing sand, gravel and rock extraction in selected EU countries

ISSN 1725-9177

European Environment Agency

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Cover design: EEA
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Layout: EEA

Luxembourg: Office for Official Publications of the European Communities, 2008

ISBN 978-92-9167-267-7
ISSN 1725-9177
DOI 10.2800/35981

Environmental production
This publication is printed according to high environmental standards.

Printed by Schultz Grafisk
— Environmental Management Certificate: ISO 14001
— IQNet — The International Certification Network DS/EN ISO 14001:2004

— Quality Certificate: ISO 9001: 2000
— EMAS Registration. Licence no. DK — 000235
— Ecolabelling with the Nordic Swan, licence no. 541 176
— FSC Certificate — registration code: SW — COC — 698

Paper
RePrint — FSC Certified 100 gsm.
CyclusOffset 250 gsm.
Both paper qualities are recycled paper and have obtained the ecolabel Nordic Swan.

Printed in Denmark

EMAS
Verified
environmental
management
REG.NO. DK-000244

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Acknowledgements

This report is based on a comprehensive analysis prepared by the EEA's Topic Centre on Resource and Waste Management. David Legg has prepared this report in cooperation with Henry Leveson-Gower, Roberto Zoboli, Marton Herczeg, Bettina Bahn-Walkowiak, Raimund Bleischwitz, Massimiliano Mazzanti, Mette Skovgaard and Gorm Dige. Gorm Dige has been the EEA project manager and has coordinated and edited the report.

We would like to thank all the contributors, especially the experts in the Czech Republic, the United Kingdom, Italy and Sweden who generously offered their views and valuable contributions to this report. Some of them were able to gather for one day in Copenhagen to discuss an earlier draft, while others sent us detailed and insightful comments. Many helped us review the documents along the way. They include (in alphabetical order):

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Executive summary

I Background

At European Community level, the Sixth Environment Action Programme (6th EAP) highlights the need to undertake '*ex post* evaluation of the effectiveness of existing measures in meeting their environmental objectives' (Article 10). To do this a better understanding is needed of policy measures and the mechanisms leading to the effects observed in the countries.

In recent years many policy-making agents have stepped up their efforts to assess policy effectiveness. In 2001 EEA published a report called: *Reporting on environmental measures: are we being effective*? (EEA, 2001). This report confirmed a widespread lack of knowledge at that time in Europe about the effectiveness of past policies for most areas. The report set out a framework for approaching effectiveness evaluations, guiding the exploration of the relationship between the needs of society for a policy measure and the final impact of that measure on the environment.

The EEA itself has become engaged in such evaluations in order to inform policy making agents and the public. For example, in 2005 it published reports on the effectiveness of national policies in the context of the Packaging and Packaging Waste Directive (EEA, 2005b) and Waste Water Treatment (EEA, 2005a). Work in this area has underlined an important lesson i.e. for environment policy to deliver effective results, the institutional setup can be as important as the design of the policy itself. Governance can therefore make or break the success of a policy.

With the aim of getting practical experience in undertaking *ex post* policy effectiveness evaluations and to provide support in selected policy areas, this report is considered a further step in that work. Furthermore studies are either planned or underway on how implementation of the Landfill and Incineration Directives influences waste recycling and recovery activities in countries and on the implementation of the IPPC Directive.

II Why consider sand, gravel and rock?

Sand, gravel and rock, which are commonly known as aggregates, are relevant in terms of their contribution to economic progress and also the impact they have on the environment. Not only does extraction of aggregates alter the landscape they also affect groundwater reserves and the cultural assets of a region, hence an important factor to consider in EU policies.

The European aggregates industry is the largest non-energy extractive sector in the EU, with 3 billion tonnes produced every year. According to Eurostat, in 2003, the Gross Value Added ([1]) of mining and quarrying, except fuels ([2]) in the EU-15, amounted to EUR 13.5 billion (EUR 15.2 billion in the EU-27).

The European aggregates industry plays a key role in Europe's economy by providing essential materials for the European construction sector. These resources are a vital input and are recognised as being strategically important in the provision of buildings and infrastructure, supporting economic expansion and the needs of growing national populations. The aggregates industry consists of more than 30 000 extraction sites across Europe. The majority of operators in the sector are small- and medium-sized enterprises. The average annual aggregates production represents 7 tonnes per EU citizen.

The environmental impacts of sand, gravel and rock use, and the activities in which they are used are far from negligible. After extraction, further

(1) Gross value-added is the difference between output and intermediate consumption for any given sector/industry. That is the difference between the value of goods and services produced and the cost of raw materials and other inputs which are used up in production.

(2) Unfortunately, no further breakdown is available for aggregates exclusively.

environmental impacts occur in the course of processing and transportation of the materials. The transport of bulky aggregate materials constitutes a significant proportion of the total cost, making it uneconomic to transport them over long distances; hence, international trade in exports and imports of aggregate materials is low.

The central focus of this study is to evaluate the effectiveness of environmental taxes that have been applied to sand, gravel and rock (either on a tonnage, volume or area basis) in selected countries to promote sustainable resource management and hence reduce environmental impacts. In cases where charges are applied, these have also been analysed to explore their potential contribution to sustainable resource management. The countries considered are the Czech Republic, Italy (Lombardy and Emilia-Romagna regions), Sweden and the United Kingdom. The countries were selected so that a range of experiences could be explored, including different geographical and political approaches. This ensured that a north, south and eastern European perspective would be included within the study, to make it possible to compare and contrast the application of taxes and charges in these settings.

III Why environmental taxes and charges?

Environmental taxes and charges are market-based instruments (MBIs) that should help realise environmental and economic policy objectives in a cost-effective way.

Environmental taxes are commonly applied to correct for market failures (e.g. negative externalities imposed on society that are not reflected in the market price of the product) and ensure that the polluter pays. The revenue from these environmental taxes usually goes into the central budget of the Finance Ministry, although a percentage may be earmarked for specific environmental objectives.

Charges on the other hand are typically applied to cover the costs of monitoring and enforcing environmental regimes (or services). For example quarry operators pay a charge to receive a licence to operate. The charge covers the cost of reviewing environmental impact assessments and monitoring compliance with permit requirements. The revenue from the charge is paid directly to the administrative body responsible for undertaking these regulatory duties and does not go to the Finance Ministry for redistribution.

IV Main findings

The objective(s) for introducing taxes or charges on sand, gravel and rock vary across countries and reflect different economic and environmental priorities

In the early 1990s, the Czech Republic introduced charges that were applied to the volume and area of extracted minerals. The system was originally designed with a prominent focus on strategic raw materials such as coal, metals and high quality mineral ores. In 2002, the scope of the charge was extended to include aggregate materials. The main objective of introducing the charges was to raise revenue and prevent the spread of mining over larger areas of land by encouraging deeper mining, thus preserving the features of the landscape.

In Italy, the application of the tax on sand, gravel and rock is decentralised and has been in operation since the early 1990s. There is no common national rate of tax applied. Instead, every

Objective of tax or charge

Czech Republic	1)	To raise revenue (both to state and municipality budgets);
	2)	To encourage deep mining and preserve the landscape.
Italy	1)	To compensate for the environmental costs caused by quarry activity;
	2)	To protect the landscape.
Sweden	1)	To safeguard gravel resources and water quality;
	2)	To preserve the landscape.
United Kingdom	1)	To compensate for environmental externalities caused by quarry activity (noise, dust, pollution, habitat loss, etc.);
	2)	To reduce demand for aggregates and encourage recycling.

region applies different rates at provincial and municipal levels, per cubic metre of sand, gravel and rock extracted. The revenue from the tax is accrued by the municipalities, and the legislation prescribes it should be earmarked for 'compensatory investments' in localities of quarrying activity. In Italy, the charge on aggregates is only one element of a very complex planning, authorisation, and regulation system related to quarrying activities. The study focuses on two large Northern regions — Lombardy and Emilia-Romagna, which together account for over 12 million inhabitants (21 % of the national total) and more than 22 % of national GDP in 2004.

The Swedish gravel tax was introduced in July 1996. The rationale for introducing the gravel tax was primarily environmental, with concerns about resource scarcity, water quality and preserving the landscape. Gravel is regarded as an invaluable resource in Sweden, since it is an important groundwater reservoir (i.e. aquifer) material; and in certain parts of Sweden, gravel beds are essential for drinking water supply where natural gravel is used as a filter for purification of drinking or sewage water. The Geological Survey of Sweden estimated that natural gravel in Sweden, given the 1996 production level, would run out in 40 municipalities within 20 years. Thus, conservation of natural gravel and material substitution to preserve the landscape were the main reasons for introducing the tax.

The UK aggregates tax was introduced in April 2002 and was justified by the presence of external costs of aggregates extraction. The objective of the UK aggregate tax has been principally two-fold. The primary aim has been to reduce the environmental costs associated with quarrying operations (e.g. noise, dust, visual intrusion, loss of amenity and damage to biodiversity). Secondly, the tax aims to reduce the demand for aggregate and encourage the use of alternative materials such as secondary aggregate materials (exempt from the tax): waste slate or shale, or recycled aggregate materials.

The market structure for extraction and recycling activities varies considerably

The table below highlights the differences in market structure across the countries. Italy has by far the greatest number of companies and sites operating in the aggregate sector, suggesting that the industry is competitive. In contrast, the United Kingdom and Sweden have much fewer companies operating, and a small number of firms have a significant market share. For example in Sweden, the market is dominated by a few very large operators with around 10 % of the firms producing almost 70 % of the total of aggregates.

Italy and the United Kingdom produce far greater quantities of aggregate materials than Sweden and the Czech Republic. This reflects the larger populations in these countries and the subsequent demand for housing and infrastructure, which requires significant amounts of aggregate materials. Sweden has the highest aggregate production per capita compared to the United Kingdom, which has the lowest. This can partly be explained by the geography of Sweden, which requires long road and rail networks to be built and maintained despite a relatively small population.

The United Kingdom has the highest recycling rate ([3]) of aggregate materials, which accounts for almost 25 % of the UK aggregates market — the largest recycled market share of any European country. Italy and the Czech Republic have very low recycling rates, which is due, in part, to a strong consumer preference for virgin aggregate materials and the lack of any significant price difference between virgin and recycled materials within these countries. In Sweden, the recycling from building and demolition waste is low, due to the current stock

	Czech Republic	Italy	Sweden	United Kingdom
Companies operating and number of sites	300 companies operating on 520 sites	1 796 companies operating on 2 460 sites	170 companies operating on 1 940 sites	350 companies operating on 1 280 sites
Total production	50 million tonnes	355 million tonnes	75 million tonnes	275 million tonnes
Total recycled	2.5 million tonnes	3 .5 million tonnes	8 million tonnes	68 million tonnes
Recycling rate	5 %	1 %	11 %	25 %

Source: UEPG.

([3]) Recycling rate is defined as % of input in aggregates.

of infrastructure having a low replacement rate. This results in a lack of material available for recycling.

A number of wider policy factors influence extraction practices

It was recognised, in all of the countries studied, that a combination of policies was needed to stimulate a change in production methods and practices. The tax or charge had often formed an important component of the policy package. It was this integrated approach that created incentives to which the industry could respond.

The primary objective of the Czech Republic was in promoting economic growth and improving housing and infrastructure. The study was unable to identify, within a broader policy environment, any measures to encourage a reduction in extraction. In fact, the high technical standards of requirements imposed on recycled materials actually created a disincentive for their use.

In Italy, the planning system exerts a strong influence over the extraction of materials. The supply of aggregates is mainly controlled by regional and provincial planning of quarrying and extraction quantities. The present environmental objectives of planning are generally aimed at minimizing external impacts, supporting sustainable management of landscapes, and providing multi-value public goods within the local area.

The Swedish study highlights the importance of recognising other wider contributory factors supporting the shift from natural gravel use to crushed rock. The two most significant policies have been the change in standards for road-building materials and a tightening of the permit regime. Both of these policies have had a strong effect on the type of extraction used and facilitated a restructuring in the industry towards crushed rock. The setting of clear environmental targets, communicated from national to regional and local municipalities, is yet another wider policy measure which has supported this change.

The study of the United Kingdom identified a number of factors that contributed to a decline in the use of primary aggregates. These included: the introduction in 1996 of the landfill tax, which has encouraged greater reuse of construction and demolition waste; a general decline, over the period, in road-building expenditure; lower intensity and improved use of aggregates in construction due to technical improvements, e.g. thinner high performance asphalt layers used in road construction.

The taxes or charges reflect different national priorities

The Czech Republic and Italy both introduced low tax rates that have remained relatively unchanged. In contrast, the United Kingdom and Sweden introduced higher taxes that have gradually been increased to provide a stronger price signal to the industry. The different rates of tax as a percentage of the average price for sand, rock and gravel are illustrated below.

In the Czech Republic, the basis of the charge relates to both the area and volume of the material extracted. The area charge is equivalent to EUR 3.6–36 (or CZK 100–1 000) per km^2 per year, in accordance with local conditions and the impact to the environment. An additional charge is levied on the volume of the extracted material, calculated as a proportion of the sale price on the market. In total, the combined charge per tonne of an aggregate material is roughly about EUR 0.1 (or CZK 3). It should be noted that a reform of the charging system is underway in the Czech Republic, which is changing the method for calculating the charge to a more ecological basis. In future, the charge will vary across the country to reflect the level of environmental impact of the quarry.

	Czech Republic	**Italy** *	**Sweden** **	**United Kingdom**
Tax as % of average price for sand, rock and gravel	3 %	5 %	12 %	20 %

Notes:

* Italy does not have a national tax rate, and so an average rate for the regions included in the study (Lombardy and Emilia-Romagna) has been used for comparison purposes.

** In Sweden, the tax only applies to natural gravel.

Source: Own compilation (using tax reports from the United Kingdom, Sweden, Italy, and Czech Republic).

In Italy, the level of tax is generally too low (around EUR 0.41–0.57 per m^3) to have had any real effect on demand. Although there are regional variations, the value of these charges at national level can be estimated at EUR 110 million, which is around 5 % of the estimated turnover of the aggregate industry. Extraction charges are not primarily aimed at reducing the quantity extracted or at promoting recycling. Instead, their purpose is to contribute to the external costs associated with quarrying activities through financing land conservation investments implemented by municipalities and other institutions that share the revenues, which mostly accrues to municipalities.

The Swedish gravel tax was introduced in July 1996 at a rate of EUR 0.53 (or SEK 5) per tonne, which corresponds, roughly, to a 10 % price increase on natural gravel. In 2003, the tax on natural gravel was raised to EUR 1.07 (or SEK 10) per tonne of extracted gravel, primarily to increase the incentive effects. It was raised a second time in 2006 to EUR 1.38 (or SEK 13) per tonne. Any company or body that exploits a site, that requires a permit under the Swedish Environmental Code, must pay the tax. However, activities within gravel pits or those associated with the aftercare at the site are exempt from the charge. Import penetration of the Swedish market is extremely low at 0.1 %, and these are not charged the tax. Exports of sand and gravel are subject to the tax, although this is applied to low volumes and seeks to maintain supply on the domestic market.

In the United Kingdom, the tax is charged on quarry operators and other organisations that commercially exploit aggregates. It was introduced at a rate of EUR 2.35 (or GBP 1.60) per tonne, which equates to approximately 20 % of the average price per tonne of material. The basis for the tax was underpinned by a contingent valuation study ([4]) that estimated the total external costs of aggregates extraction in the region of EUR 558 (or GBP 380) million per year. In the 2007 Budget, it was announced that the rate of the tax would increase to EUR 2.87 (or GBP 1.95) per tonne from 1 April 2008, to take account of inflation since the introduction of the tax. Not all aggregates are subject to the tax — certain secondary aggregate materials, such as waste shale and slate, for example, are not taxable — and in certain cases, depending on what use the aggregate is to be put to, exemptions may apply. If the aggregate is to be supplied to people outside the United Kingdom, then the tax is refundable, and any aggregates imported from outside the United Kingdom become subject to the tax once they are commercially exploited.

The effect of the tax in relation to the national objectives provided mixed results

Each of the country studies involved an analysis of the effect of the tax in relation to the national objectives. Further details of the methodological approach used to undertake this assessment can be found in Annex 1. Below are the summaries from the findings for each national objective.

- To reduce environmental externalities ([5]) (objective in Italy and the United Kingdom)

  In Italy, there was no evidence to show that tax had had any effect on reducing environmental externalities in either of the two regions included in the study (Lombardy and Emilia-Romagna).

  In the United Kingdom, there was no quantitative data available to show any improvement. This was because of the lack of any measures in place. Neither government nor industry provided any evidence to show that the aggregate tax brought about reductions in noise and vibration; dust and other emissions to air; visual intrusion; loss of amenity and damage to wildlife habitats. This was despite the UK tax being underpinned by a contingent valuation study that estimated the total external costs of aggregates extraction in the region of EUR 558 (or GBP 380) million per year.

- To preserve the landscape (objective in Czech Republic, Italy and Sweden)

  Interviewees in the Czech Republic confirmed that there had been a modest reduction in the number of operating quarry sites, leading to an improvement in land use in these areas. However, this has not been accompanied with a reduction in the quantity of aggregates, since the decline in quarry sites has taken place at sites already out of operation or with production close to zero. There was a lack of

([4]) London Economics, 1994.
([5]) Environmental externalities relate to noise, dust, and pollution generated through quarry activities.

evidence to show that the tax had any effect in discouraging deep mining and preventing the spread of surface activity.

In Italy, it was not possible to make a detailed evaluation of the use of revenue from the aggregate charge by the local administrations. At the same time it was reported that the revenue was often used for land conservation investments, e.g. restoring old quarry sites not restored in the past. In Sweden, there was a strong evidence of the shift from the gravel pit extraction to larger numbers of rock quarries. This was associated with preserving gravel mounds as a natural feature.

- To reduce demand for aggregates and encourage recycling (objective in Sweden and the United Kingdom)

  In Sweden, the tax level gradually increased over time, which acted as a signal to producers and facilitated a gradual restructuring process. Analysis by Swedish Geological Unit is inconclusive as to whether the shift from gravel to crushed rock is caused by the tax. The Ministry of the Environment was of the view that the tax had helped to sustain the shift as part of a package of policy measures. These included, among others, a tightening of the permit regime.

  In the United Kingdom, analysis undertaken by HM Revenue and Customs indicated a slight reduction in aggregate sales following the introduction of the aggregate tax. However, there was a lack of data over several years to show a significant and conclusive result. Industry research showed a modest shift to alternative 'untaxed' secondary waste materials, e.g. slate, shale and china sand. Research undertaken by the Waste Resources Action Programme ([6]) provided evidence of an increase in recycling activity, which they predicted to continue and expand in the future.

V What can we conclude more broadly?

The findings from this study and the lessons from the application of taxes and charges on natural resources (sand, gravel and rock) in the selected countries are relevant to the discussions taking place on sustainable production and consumption and the use of MBIs across Member States. Below are some broad lessons distilled from the study on the application of environmental taxes that can help inform the development of EU policy in this field.

Taxes need to be used as part of a package of policy interventions

They should be subject to a systematic analysis of factors that influence the extraction of sand, gravel and rock resources. The combination of taxes and other policy levers, introduced as a package of policy measures, is likely to be more effective in delivering environmental improvements. For example, the Italian study highlights the importance of the regional/provincial planning systems in controlling quarrying activities and extraction quantities. Such systems minimise external impacts and support the sustainable management of landscapes to provide environmental benefits to local areas.

There are difficulties in reflecting environmental damages in the size of the tax

The Czech Republic is revising the basis for its mining charge to reflect the ecological impact. However, calculating the ecological score is complex, and concerns have been raised about whether the administrative costs will exceed the benefits. It is interesting to note that none of the other countries, included in the study, have attempted to vary the tax or charge across different locations to reflect the extent of environmental damage.

In designing a tax, it is necessary to consider wider environmental impacts and trade-offs at an early stage

In Sweden, the benefits of preserving natural gravel for groundwater reservoir (i.e. aquifer) material were deemed to be greater than the costs from the greater energy use in extraction. The overall effect of the tax had some unintended consequences. The substitution towards crushed rock required approximately three times more energy per tonne of material in comparison to natural gravel. Unfortunately, no measures were available to compare the costs and benefits of these impacts.

([6]) WRAP is a government-funded agency that encourage and enable businesses and consumers to be more efficient in their use of materials and recycle more things more often.

Use of revenue raised from the tax needs further analysis

Earmarking of the revenue can help reinforce the impact of the tax. However, it needs to address specific market failures and to improve environmental outcomes. For example, the United Kingdom used a proportion of the tax revenue to develop quality standards for recycled aggregates, which gave companies confidence in purchasing and using these materials. This was reinforced through awareness-raising campaigns to encourage local authorities to purchase recycled materials when carrying out local infrastructure projects.

Tax distortions across country borders need to be taken into account when deciding on the appropriate rate of the tax

Coordination is imperative where countries have natural land borders, and differences in tax rates can lead to perverse trade flows. This can lead to an overload of extraction in the lower or no tax regions. For example, the study of the United Kingdom highlighted an unintended trade-distorting effect, due to the proximity of Northern Ireland (with aggregate tax) to Ireland (without tax).

Indirect effects of the tax from improvements in the quality of information arising from monitoring of the extraction activity

This indirect effect was registered in both Sweden and Italy where, previously, the monitoring was either approximate or non-existent. The requirement for the authorities, in order to calculate the tax, to know exactly how much aggregates is extracted per year made it necessary to develop better systems for monitoring the activities at a quarry level. The tax has, therefore, helped improve the quality and reliability of extraction data, which can then be used as a basis for encouraging changes in quarry management activities.

Design additional monitoring systems to assess the change in impact on the environment

When applying taxes and charges on aggregates it is important not only to focus on the economic effectiveness but also the environmental effectiveness. An additional monitoring system would help assessing whether the size of a tax or a charge have positive or negative impacts on the environment and hence reveal the environmental effectiveness of these levers.

Introduction of taxes did not lead to changes in the competitiveness of the aggregate sector

In part, this was due to the nature of the product, with the transport of bulky aggregate materials constituting a significant proportion of the cost. This makes it uneconomic to transport products over long distances, and production is constrained by local demand factors. Because of the limited volume of trade in this area, international competitiveness is not a major concern of the aggregates industry.

1 Introduction

1.1 What has the EEA done on policy effectiveness evaluations and market-based instruments?

At European Community level, the Sixth Environment Action Programme (6EAP) highlights the need to undertake '*ex post* evaluation of the effectiveness of existing measures in meeting their environmental objectives' (Article 10). To do this, we need to get a better understanding of policy measures and to examine the mechanisms leading to the effects observed in the countries. We need to know:

- which measures were implemented by the Member States in order to transpose and implement a piece of European legislation;
- the effects of such measures; and,
- the national context in which the measures are designed to operate.

In recent years many policy-making agents have stepped up their efforts to assess policy effectiveness. In 2001 EEA published a report called: *Reporting on environmental measures: are we being effective?* (EEA, 2001). This report confirmed a widespread lack of knowledge at that time in Europe about the effectiveness of past policies for most areas. The report set out a framework for approaching effectiveness evaluations, guiding the exploration of the relationship between the needs of society for a policy measure and the final impact of that measure on the environment.

The EEA itself has become engaged in such evaluations in order to inform policy making agents and the public. For example, in 2005 it published reports on the effectiveness of national policies in the context of the Packaging and Packaging Waste Directive (EEA, 2005b) and Waste Water Treatment (EEA, 2005a). Work in this area has underlined an important lesson:

- governance can make or break the success of a policy. The institutional setup can be as important as the design of the policy itself;
- by tackling problems at source, economic instruments can be effective ingredients in the policy mix;
- in assessing a policy's goal-achievement, it is important to distinguish between different types of goals;
- data limitations are demanding, but not insurmountable;
- effectiveness evaluations are complex and require multidisciplinary efforts;
- effectiveness evaluations contribute to capacity building and shared policy learning (EEA, 2005f).

With the aim of getting practical experience in undertaking *ex post* policy effectiveness evaluations and to provide support in selected policy areas, this report is considered a further step in that work. Further studies are either planned or underway on how implementation of the landfill and incineration directives influences waste recycling and recovery activities in countries and on the implementation of the IPPC Directive.

The EEA has for some time been drawing attention to the use of MBIs across the EU Member States as a policy tool. Earlier reports from the EEA (EEA, 2006b; EEA, 2005d) have argued that MBIs can be particularly effective tools for dealing with the four major areas of action of the EU 6th EAP, namely: tackling climate change, preserving nature and biodiversity, protecting environment and human health, and the sustainable use of resources and management of wastes.

1.2 Objectives of this study

This study provides an *ex-post* effectiveness evaluation of taxes on natural resources, i.e. sand, gravel and rock (also called aggregates), as a market-based instrument (MBI) to promote resource productivity and hence reduce environmental impacts. Charges have also been reviewed to explore their potential contribution to sustainable resource management.

MBIs like taxes and charges can help realise environmental and economic policy objectives in a cost-effective way.

Environmental taxes are commonly applied to correct for market failures (e.g. negative externalities imposed on society that are not reflected in the market price of the product) and ensure that the polluter pays. The revenue from these environmental taxes usually goes into the central budget of Finance Ministry, although a % may be earmarked for specific environmental objectives.

Charges on the other hand are typically applied to cover the administrative costs of monitoring and enforcing environmental regimes (or services). For example quarry operators pay a charge to receive a licence to operate. The charge covers the cost of reviewing environmental impact assessments and monitoring compliance with permit requirements. The revenue from the charge is paid directly to the administrative body responsible for undertaking these regulatory duties and does not go the Finance Ministry for redistribution.

The emphasis of the study is on sharing good practice with the following main objectives:

1. to analyse the contribution of taxes and charges to increase natural resource productivity;

2. to increase understanding of the use of taxes and charges in resource management by comparing approaches used in different countries and sharing the lessons.

The study looks specifically at the experiences from the four EU Member States that have introduced charges on sand, gravel and rock. The countries were selected on such a basis that a range of experiences could be explored, including different geographical and political approaches. The countries selected included the Czech Republic, Italy (represented by the regions Emilia-Romagna and Lombardy), Sweden and the United Kingdom. This ensured that a North, South and Eastern European perspective would be included within the study, which made it possible to compare and contrast the application of taxes and charges in these settings.

But why do we focus on sand, gravel and rock? These aggregates play an important economic role as building materials in particular for infrastructure and construction work the latter revealing to be one of the products with the highest environmental pressures (EEA, 2007). Not only does extraction of aggregates alter the landscape they also affect groundwater reserves and the cultural assets of a region hence an important factor to consider in EU policies.

The publication of this report is timely, given the discussions on sustainable production and consumption and on the enhanced use of MBIs across Member States. The findings from this study and the lessons from the application of MBIs on natural resources (sand, gravel and rock) are highly relevant in this context and can inform the development of EU policy.

The methodological approach used in this analysis has been to analyse data, review existing reports and to work with recognised experts in the selected countries in order to understand the objectives of the MBI and relationships with other policy instruments. This has involved undertaking a systemic analysis of the main factors influencing the use of sand, gravel and rock resources to assess whether the MBI achieved the intended environmental objective(s).

The methodology is split into two main areas. The first relates to the technical analysis, which includes quantitative and qualitative analysis using existing data and information provided by industry and government sources. The second covers the process design, i.e. identifying who should be involved when, where and how. Process design is essential if the full learning benefits are to be gained from the technical analysis. For more information on the methodological approach please refer to Annex 1.

1.3 Market-based instruments seen as an increasingly important policy tool for the future

MBIs are increasingly considered an important and underused tool for achieving environmental outcomes. In March 2007, the European Commission launched a Green Paper ([7]) on advancing the use of MBIs across the Member States to support environment and energy policies. It concluded that

([7]) COM(2007)140 final.

there should be an increased use of market-based instruments to achieve environmental and other policy objectives and recommended establishing an MBI forum to stimulate exchanges of experience and best practice between the Member States.

The European Commission has also established the 'Brussels Tax Forum'. With this conference the Commission aims to begin a tradition of annual meetings that would bring together policy makers, experts, stakeholders and the general public from all over the world in order to discuss tax issues of particular and general interest. Its first meeting took place in March 2007 and looked into 'taxation for sustainable development'. The conference focused on the contribution that taxation can make to sustainable development. It considered how taxation can promote other policy objectives, such as environmental protection, while bearing in mind economic and social aspects.

The more intensive use of MBIs has also been advocated in the EU action plan — Sixth Environment Action Programme (6EAP) and the renewed EU Sustainable Development Strategy, as well as the renewed Lisbon Strategy for Growth and Jobs. The 6EAP promotes the idea of 'pushing the market to work for the environment' by both including environmental costs in the price of products and services and developing agreements between environmental policy institutions and economic actors.

The EU 'Thematic Strategy on the Sustainable Use of Natural Resources ([8])' calls for greater decoupling and increasing resource productivity, which could be achieved through appropriately designed MBIs. Among the examples are charges and taxes, tradable-permits systems, deposit-refund-systems, recycling fees, and voluntary agreements with industry that include economic commitments such as 'producer responsibility'.

The Member States have also shown an increasing interest in using MBIs to achieve policy objectives, given their potential for efficiency gains over traditional regulatory approaches. According to the EEA/OECD database ([9]), most EEA member countries are already using MBIs or are in the process of introducing them in various environmental fields, particularly in the new Eastern EU Member States. Meanwhile, analysis undertaken by Eurostat highlights that taxes applied to energy resources are much greater than those imposed on other natural resources (as shown in Box 1.1):

Box 1.1 Environmental taxes

Environmental taxes can be divided into four broad categories: energy, transport, pollution and resource taxes. In 2005, energy taxes were by far the most significant, representing around three quarters of environmental tax receipts and around one twentieth of total taxes and social contributions. In the EU-27, transport taxes correspond to, on average, slightly less than one fourth of total environmental tax revenues and 1.5 % of total taxes and social contributions. The remaining two categories — pollution taxes and resource taxes, raise only a marginal amount of revenue: together they make up just 4.1 % of total environmental taxes.

Source: 'Taxation trends in the European Union', Eurostat, 2007.

1.4 Recent EU developments on natural resources

An EU Commission study undertaken on behalf of DG Enterprise ([10]) of minerals planning policies of the non-energy ([11]) extractive industry in Europe concluded:

- there was limited knowledge of importance of non-energy extractive industry in Europe (lack of reliable statistics due to large number of small and medium sized companies);
- lack of appreciation of strategic importance of non-energy minerals (particularly aggregates;
- in most Member States non-energy minerals are considered a low priority;
- in most Member States access to mineral deposits is becoming more difficult;
- time required for authorisation of mineral extraction tends to be very long and the outcome is often uncertain;

([8]) COM(2005)670 final.
([9]) OECD/EEA database and ETC/RWM research, (2005) — Working paper, 2005.
([10]) Wagner and ties, DG Enterprise/Leoben University 2004.
([11]) Non-energy is defined as construction minerals, industrial minerals and metallic ores.

- increasing environmental pressures on the non-energy extractive industry.

DG Enterprise undertook a further analysis ([12]) of the competitiveness of the non-energy extractive industry in the EU. This assessed a number of factors that were considered to have the biggest potential impact on the competitiveness of the sector. These included: exploration, investment and operating costs, the regulatory framework, access to resources within the EU, the availability of a skilled workforce, research and innovation and health and safety requirements. Access to land was identified as the key challenge for the industry, due to conflict with other land uses.

In response to these findings the Competitiveness Council (May 2007) requested the Commission to develop a coherent political approach with regard to raw materials supplies for industry, including all relevant areas of policy (foreign affairs, trade, environment, development and research and innovation). The Commission has been asked to identify appropriate measures for cost-effective, reliable and environmental friendly access to and exploitation of natural resources, secondary raw materials and recyclable waste, especially concerning third country markets.

The conclusions of the G8 summit in Heiligendamm (June 2007) highlighted 'Responsibility for Raw Materials: Transparency and Sustainable Growth'. The leaders recognised that raw materials in the extractive industry are a key factor for sustainable growth in industrialised, emerging and developing economies.

The EU's Sustainable Development Strategy acknowledges that competitiveness, energy and environmental policies are closely interrelated and that their impact is of significant importance, particularly for many basic and intermediate product industries. This was recognised in the Communication on Industrial Policy, the European Commission tabled in October 2005 ([13]). To ensure seamless integration between the three policy areas, it recommended the creation of a High Level Group on competitiveness, energy and the environment.

The High Level Group was launched in February 2006. The fourth report (EC, 2007) from this High Level Group was adopted on 11 June 2007. The findings from this report highlighted the need for a raw material policy. It recommended that taxation system reforms and other policy instruments should be designed carefully, in order to ensure resource productivity and efficiency gains while avoiding possible relocations that would displace the EU ecological footprint outside the EU.

In an increasingly globalised economy, the challenge for European policy-makers is to streamline actions for ensuring a more sustainable use of renewable and non-renewable resources. Although existing policies on climate change or conservation of biodiversity already tackle many of the global resource challenges, a holistic framework is needed to help identify their interlinkages and gaps in a systemic way.

The establishment of the International Panel for Sustainable Resource Management (Resource Panel) is a first step towards addressing this need. The Panel is expected to tackle resource efficiency challenges for both renewable and non-renewable resources from a life-cycle perspective, as well as addressing their cross-cutting socio-economic issues. The overall objective of the Resource Panel is to provide independent scientific assessment on environmental impacts due to the use of resources over the full life cycle, and advise governments and organisations on ways to reduce these identified impacts. The ultimate goal is to increase resource-efficient market development globally, and stimulate sustainable innovation leading to the decoupling of economic growth from environmental degradation.

In 2007 the extractive industry launched the UEPG Sustainable Development Awards (UPEG, 2007) to promote the spread of best practice and encouraging projects which go beyond what is required by planners or regulators.

In addition, the industry participates in the European Technology Platform on Sustainable Mineral Resources. This was established in 2006 with the following aims: to reshape a traditional industry from being resource-driven to a knowledge driven industry; to foster new and better jobs, particularly at the level of small and medium size companies and in the new Member States; to supply and secure the mineral resources needed by the European economy, while minimising the related environmental footprints; to strengthen competitiveness of the technology of the mineral industry, and to add value for customers and society.

([12]) SEC(2007)771, Commission staff working document 2007.
([13]) COM(2005)474 final.

2 Economic and environmental importance of sand, gravel and rock

2.1 Economic and environmental relevance

Aggregates like sand, gravel and rock are relevant in terms of their contribution to economic progress and also the impact they have on the environment. The European aggregates industry is the largest non-energy extractive sector in the EU, with 3 billion tonnes produced every year. According to Eurostat, in 2003, the GVA of mining and quarrying, except fuels in EU-15, amounted to EUR 13.5 billion. Unfortunately, no further breakdown is available for aggregates exclusively.

The European aggregates industry plays a key role by providing essential materials for the European construction sector. These resources are a vital input and are recognised as being strategically important in the provision of buildings and infrastructure, supporting economic expansion and the needs of growing national populations. The aggregates industry consists of more than 30 000 extraction sites across Europe, and a majority of operators in the sector are small- and medium-sized enterprises. The average annual aggregates production represents 7 tonnes per EU citizen. The construction sector also employs more people than any other industrial sector, with 12 million people, or 7 % of the total workforce, being directly employed in the sector across Europe.

The extractive industry can only operate where the geological resources are present in sufficient quantity and quality, and at depths that can be worked economically with the available technology. As the resource in a particular area is finite, and often of variable quality, the industry occupies an area of land for a limited time — even if this period spans just a few years to many centuries. The industry, therefore, if it is to remain in operation, has to discover and work new resources to replace those that are becoming, or have become, exhausted. Most new resources are found close to existing operations, as exploration activities tend to concentrate around the same areas. Most new operations are, therefore, extensions of existing sites, although new 'greenfield' sites are also developed.

The location of many downstream industries has long been a direct consequence of locally available mineral resources, and local stone used in buildings has given many villages, towns and cities their unique characteristics. A number of downstream sectors are vertically integrated with the extractive industry. Companies producing cement, for example, usually operate their own quarries in the vicinity of their manufacturing plant in order to reduce the cost of transporting the raw materials.

Aggregates are often used as an end-product in themselves — as railroad ballast, filter beds or flux materials. They are also used as a raw material in the manufacture of vital construction products, such as ready-mixed concrete, mortar, pre-cast products and asphalt. Their main application area is the building and construction sector (UEPG, Annual report, 2005: 5).

Sand, gravel and rock are used for the goods of final demand listed below.

(a) Homes — the construction of a typical new home uses up to 60 tonnes of aggregates (both end-product and concrete) — from the foundations through to the roof tiles.

(b) Other buildings and public places — from commercial buildings, local hospitals and schools to bridges and flood protection, most buildings are made from aggregates. In many cases they provide not just strength but contribute, through special finishes, to architectural beauty. The construction of a school uses up to 3 000 tonnes of aggregates. For a conventional sports stadium, up to 300 000 tonnes are needed.

(c) Roads — aggregates are used at all levels of the road construction up to the surface, including aggregates resistant to polishing, ensuring skid-resistance. The construction of 1 km of motorway uses up to 30 000 tonnes of aggregates.

(d) Railways — aggregates are essential as track ballast for Europe's rail network. The construction of 1 metre railway for High Speed train (TGV) uses up to 9 tonnes of aggregates.

By way of an illustration, the UK Quarry Products Association estimates that aggregates were used in the following proportions in the UK construction industry: approximately 16 % were used for housing; 22 % for road-building and maintenance; 27 % for private industrial and commercial development, and 11 % for other public works.

Lafarge Granulats estimates that of the 400 million tonnes of aggregates used in France, 17 % were used in ready-mixed concrete, 13 % in asphalt and 55 % in applications such as road sub-base layers, ornamental purposes and filtration. Broadly similar figures were provided by Finland: 50 % for roads, 10 % in asphalt, 10 % in concrete, 15 % in house building and 15 % for other uses.

Sand, gravel and rock are related to sustainable resource management in two main ways:

1 Their material intensity from the construction and engineering sectors, i.e. their relevance for increasing resource productivity in the European Union as part of the Lisbon strategy, and the Sustainability Strategy.

2 Their environmental intensity from extraction activities, i.e. their relevance for increasing eco-efficiency and for lowering environmental impacts in the European Union.

The European Sustainable Development Strategy, subsequent national strategies and the Thematic Strategy on the Sustainable Use of Natural Resources alike, call for a decoupling of natural resource use from the GDP growth. The sand, gravel and rock extraction industry together with the construction industry can be considered the most resource-intensive sector throughout Europe in terms of the volume of material used. According to Eurostat, in 2002, they represented 40 % of the Direct Material Inputs (DMI) into the European economy while mineral fuels represented another 25 % ([14]).

The life cycle environmental impacts of sand, gravel and rock use are far from negligible. The extraction process will alter the landscape, often affecting the cultural assets of a region and the groundwater. After extraction, further environmental impacts occur within processing and transportation of the materials.

2.2 Economic and environmental pressures

Despite the strategic importance, aggregates and construction can be considered a moderate growth market in Europe. Forecasts for housing and construction markets across the EU are in the order of 2 % of the annual growth, with a higher growth expected for commercial buildings, infrastructure and maintenance of existing stocks. In regional terms, the new member states: the Czech Republic, Hungary, Poland, and Slovakia, as well as Spain — are expected to have the highest increase in demand. In comparison, the United Kingdom, France and Italy are likely to remain in a stable position, while Germany and Portugal are likely to stagnate or may even decline further.

Demand for aggregates is closely related to the level of new house-building, maintenance and repair of existing buildings, and the scale of civil engineering projects. During periods of weak economic growth, repair and maintenance of the existing building stock is thought to dominate demand, although this depends on the extent of the existing building stock and the number of national and local urban renewal programmes. In the Netherlands, Germany, France and Italy, renovation of the existing stock accounts for the majority of the market, while in the United Kingdom and Belgium, there is parity between new construction and renovation. In Portugal, Ireland and Spain, and new Member States, new construction predominates.

The extractive industry of sand, gravel and rock differs in at least two important aspects from most other industrial sectors. First, the location of the industry and the quality of the material produced is determined by geology in relation to areas of high demand, i.e. large cities.

Second, the success of the sector is dependent on the success and competitiveness of the downstream industries. Economic success, therefore, is controlled by two factors: quality and quantity of deposits of natural resources for aggregates and the political, legal, administrative, social and economic environment in which extraction takes place (Wagner/Tiess, 2004: 27). For both reasons, aggregate companies are used to taking a long-term perspective. They need to ensure the supply of aggregates and to obtain permits, which takes on average 10 years.

([14]) Presentation of Steering Committee of the European Technology, Platform on Sustainable Minerals, Brussels, January 2006.

Prices are an important driver of sand, gravel and rock supply. There are three major structural factors relative to the operation of the sector that lead to inelastic supply and demand.

First, since it normally takes at least four years to bring new aggregates capacity on-stream, the short-run supply is relatively inelastic and prices remain stable.

Second, once capacity exists and fixed costs have been incurred, producers are reluctant to curb output as long as some contribution is being made towards overheads.

Third, the nature of the aggregate materials, being low-cost bulky products, means the economic supply radius of a quarry is very low. Firms are very transport-sensitive, with the portion of transport costs in the extraction sector being around 13 % of total costs. This makes it uneconomic to transport the materials further than around 35– 50 kilometres (dependent on diesel prices).

The main environmental pressures associated with the production and consumption of sand, gravel and rock material resources is described in the following categories:

1 Extraction and land use issues;

2 The environmental pressure they generate through extraction, transport, use and further processing (i.e. energy, water and emission issues).

Extraction

Extraction activities often have a negative environmental effect, although the damage varies, depending on the type of extraction. All extraction activities lead to the disturbance of land, air, and water ecosystems. Opencast extraction sites have the largest impact on ecosystems, as large areas are cleared to extract deposits. This often leaves behind a desolate landscape, devoid of life or living resources.

According to the UN Millennium Ecosystem Assessment (2005) ([15]), ecosystems provide essential services for human societies: supporting services such as soil formation; provisioning services such as freshwater; regulating services such as water purification; and cultural services such as recreation areas. Sweden, for instance, benefits from water purification services provided by sub-soil gravel. The extraction of aggregates, certainly, has an impact on those ecosystem services.

The energy use for the extraction of sand, gravel and rock is comparatively low (Ecoserve, 2004). Most of the energy consumption and emissions result from the use of transport: within quarries, from quarries to local customers and to the location sites for further processing. This is increasingly significant in the case of more remote quarries. The average water consumption of gravel is particularly water-intensive (UEPG 2006, p. 16).

Land use

The land used for the domestic extraction of aggregates is only a small proportion of the total area of the EU countries, compared to other materials like biomass. For Germany, which is the second largest producer of aggregates at present, the land use equivalent for the extraction of 312.7 million tonnes of sand and gravel and 136.8 million tonnes of crushed rock was 14 115 square kilometres in 2001 ([16]). This is equivalent to less than 0.005 % of the total area of Germany. According to Eurostat, the combined land requirement for mining and quarrying amounts to 0.5 % of the total area in Germany.

During the time that a quarry is in operation, land that is used for the mining and quarrying of sand, gravel and rock cannot be put to any other use, such as agriculture, recreation or residential development. However, quarry restoration projects are now a common practice across Europe, and these are increasingly used to improve wildlife habitats and biodiversity at the end of the quarry life.

From a material flows perspective, the use of sand, gravel and rock resources contribute to the material accumulation of a country, referred to as 'physical net addition to stock'. The average growth rate of the physical economy is estimated to be at 10 tonnes per capita each year. This is the amount of material that is being stocked in new buildings and infrastructures, which entails additional soil sealing, maintenance and energy costs. The built-up area can be regarded as an indirect land use of aggregates (Voet, 2004: 134 and 123).

([15]) Internet: www.millenniumassessment.org.
([16]) This figure does not contain land use for excavation. Extraction figures British Geological Survey 2007.

Extraction of construction materials, including sand, gravel and rock causes not only greenhouse gas emissions, noise and air pollution, but also transformation of land into built-up areas, resulting in significant losses of the basic natural functions of the land. In Europe, our consumption patterns are completely different from what they were twenty years ago. Transport, new types of housing, tourism and leisure have emerged as major components of household consumption, which all require land and use of construction materials like aggregates. It is projected that by 2020, approximately 80 % of Europeans will be living in urban areas, while in seven countries the proportion will be 90 % or more. As a result, the various demands for land in and around cities are becoming increasingly acute and are a matter of great concern as European cities are spreading (EEA, 2006a).

Processing

The different production and application areas of sand, gravel and rock materials generate severe environmental impacts. Two products are of particular importance in the context of energy and emission intensity with downstream processing of these materials, namely — concrete and cement.

Concrete is the most important building material in the world, the average production is between 2 and 3 tonnes per capita per year. About 70–80 % of concrete consists of aggregates (Ecoserve, 2004). A further 10–15 % of the concrete contains cement and the production of 1 kg of cement generates about 1 kg of CO_2 emissions. The average amount of cement in 1 m^3 of concrete is about 283 kg ([17]).

Transport

The wide distribution of minerals suitable for use as aggregates across the European Union, combined with the high demand and their relatively low cost per tonne, means that markets tend to be relatively close to the production sites. This requires a tight network of pits and quarries, in order to reduce transport distances and the cost of transport. There are also a number of very large sites which are usually closely linked to rail or harbour facilities and serve more distant markets. Although the transport distances may be short, the frequency of journeys can be high. Indeed, the tonnage of aggregates transported in Germany via freight vehicle amounts to 45 % of total goods transported (Bundesamt für Güterverkehr 2006).

Trade

Within Europe, there is a growing trade of aggregates. In 2004, main net importers were the Netherlands, Belgium/Luxembourg and Switzerland, main net exporters — Norway, Germany and United Kingdom (Figure 3.4 and Chapter 4). Comparisons with figures for 2001 show a tendency of increasing trade, particularly within central and northern Europe. This does not only affect transport but also energy costs and transport-related emissions. Due to its relatively high value, natural stone has become an important export product, with North America in particular providing a significant market outlet for European producers; competition is increasingly present from low-cost producers in countries such as India, Brazil and China.

Gravel is heavy and constitutes a significant component of the overall material demand. However, this material flow is lightly processed and is often obtained from local sources. In contrast, manufactured products require far more ecological services per tonne to deliver the final products, and are the ones that are typically traded. The worldwide demand for construction aggregates is estimated to be rising by 4.7 % annually through 2007, driven by infrastructure construction in countries like China, India, Poland, Russia, Taiwan, Thailand and Turkey ([18]). Only fragmentary data are available for the proportion of aggregates in the long-distance goods transport.

Disposal

Extractive operations often generate large volumes of waste due to the normally high waste-to-product ratios. These wastes are often major sources of pollution, including topsoil, overburden, waste rock and tailings. Demolition generates high volumes of waste that uses valuable space if landfilled. The recycling rates of construction and demolition waste are expected to increase in future. However, recycling rates still have to be interpreted with caution, as they presently tend to be over- or underestimated due to different ways of accounting of recycling, secondary use, etc.

The order of magnitude, however, correlates to the different national availability throughout Europe and the transportation costs.

([17]) One cubic metre of m^3 concrete corresponds to about two metric tonnes (Ecoserve, 2004: 53).
([18]) Internet: http://www.freedoniagroup.com/World-Construction-Aggregates.html.

A recent success in improving the recycling rates of construction and demolition waste is described in the case story for Denmark (Box 2.1 and Figure 2.1).

Box 2.1 Case story: construction and demolition waste in Denmark

Construction and demolition waste consists primarily of concrete, asphalt, stone, soil and other construction and demolition waste. The Danish EPA has estimated that in 1985, 82 % of the construction and demolition waste was landfilled, 12 % recycled and 6 % incinerated, Ministry of the Environment (1992). Since then the situation has been reversed, so that 94 % of construction and demolition waste was recycled in 2004. The same year, 4.5 million tonnes of construction and demolition waste was generated, which equalled 34 % of the total waste generation in Denmark. The generation and management of construction and demolition waste is shown in Figure 2.1 below.

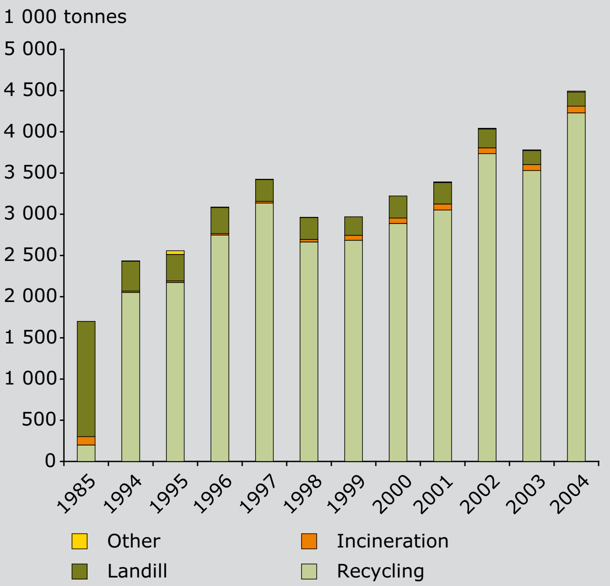
The strategy for diverting construction and demolition waste from landfills and achieving the high recycling rate has been a combination of the carrot and the stick: taxes, subsidies and regulation. The main measures have been the waste tax, regulation to separate construction and demolition waste at source, and significant government support for increased recycling possibilities. The waste tax was introduced in 1987, with a tax of DKK 40 (EUR 5.3) per tonne of waste landfilled or incinerated. Recycling is exempt from the tax. In 1993, the tax was differentiated; and for landfill, the rate increased dramatically to DKK 335 (EUR 45) and in 1998 to DKK 375 (EUR 50) per tonne.

An evaluation of the effects of the Danish waste tax was published in 1999, and it concluded that a marked increase in recycling had taken place, in particular of heavier fractions such as construction and demolition waste and fractions that are relatively easy to separate. The tax has also been influential in reducing the amount of construction and demolition waste (Andersen *et al.*, 1999). Construction and demolition waste is mainly recycled in construction works as filler, hard core in road construction and as noise barricades. Due to the high tax on landfill, many efforts are made to increase recycling. However, some examples of 'creative recycling' have also occurred.

Regulation on the separation of construction and demolition waste for recycling took effect from 1997. It stipulates that waste from demolition works involving more than 1 tonne of construction and demolition waste has to be separated at source into pure fractions, e.g. asphalt, bricks, soil. Around the same time, the Minister for the Environment also entered into an agreement with the industry on selective demolition of building materials (Danish Government, 2003).

Over the period 1993–1997, through the government support programme, DKK 101 million (EUR 13.5 million) was granted to 120 projects in order to implement a cleaner technology and encourage recycling in the building and construction sector (Danish EPA, 1997a). After 1997, the government launched several other programmes, e.g. the Programme for Cleaner Products that ran from 1999 to 2003.

Figure 2.1 Generation and management of construction and demolition waste in Denmark, 1985–2004



Note: In 2002, the waste statistics was expanded to include more soil and stone.

Source: Danish EPA, 2006, Waste statistics.

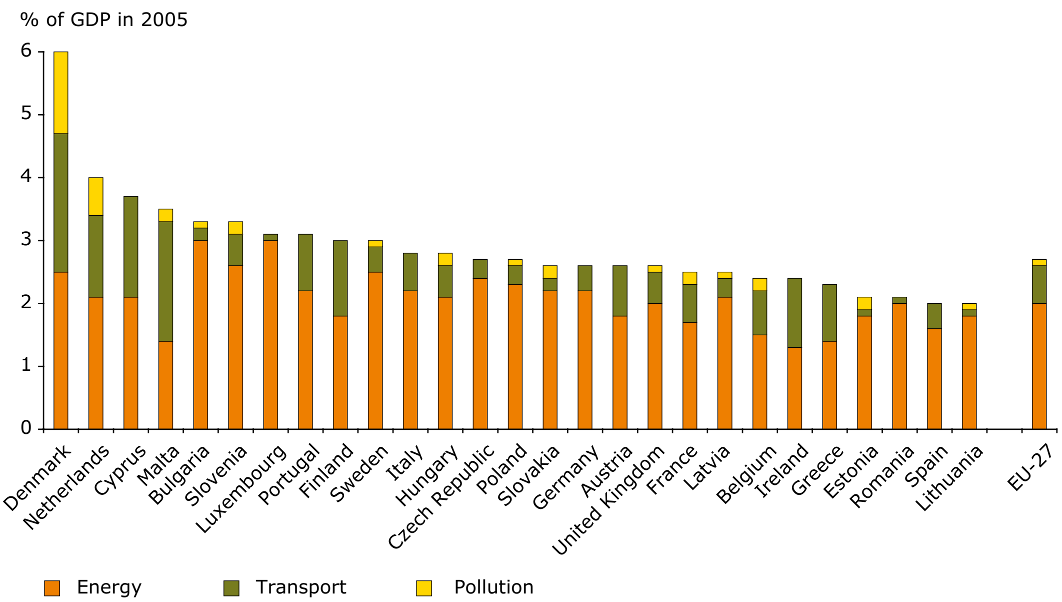
3 Overview of European aggregates and taxes

Environmental taxes can be divided into four broad categories: energy, transport, pollution and resource taxes. Energy taxes are by far the most significant, representing around three quarters of environmental tax receipts and around one twentieth of total taxes and social contributions. In the EU-27, transport taxes correspond to, on average, slightly less than one fourth of total environmental tax revenues and 1.5 % of total taxes and social contributions (in the weighted average). The remaining two categories, pollution taxes and resource taxes, raise only a marginal amount of revenue: together they make up just 4.1 % of total environmental taxes (Eurostat, 2007).

Figure 3.1 below shows the environmental tax-to-GDP ratio by Member State and breaks it down by type of tax. The relative importance of each type varies across countries, but in general, most MSs tend to fall in a band ranging from 2 % to 3 % of GDP, or slightly higher. Only two Member States show levels below 2 % of GDP, while only in three countries environmental tax revenues exceed 3.5 % of GDP. At 5.8 % in 2005, Denmark displays by far the highest level of 'green' taxes followed by the Netherlands (4.0 %). The lowest environmental tax revenues in relation to GDP are found, instead, in Lithuania (1.9 %) and Spain (rounded up to 2.0 %).

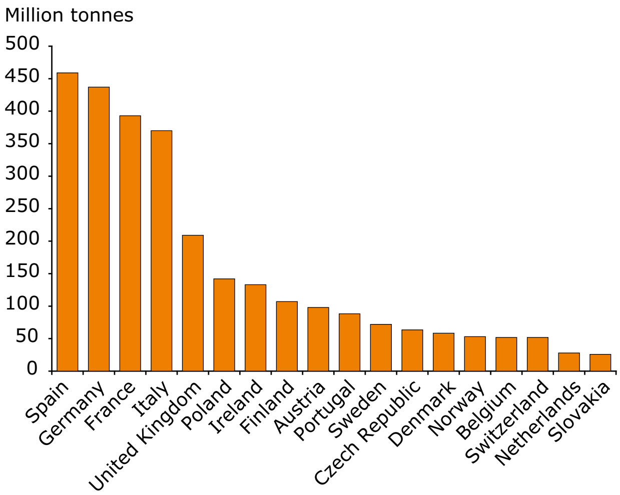
The main driving forces for aggregates arise from the downstream demand of housing and construction. The aggregates industry is present in every Member State, although the amount produced varies greatly between countries. States with low density of population, such as Sweden and Finland, use a higher share of aggregates for roads construction, whereas new Member States are concentrating on improving their infrastructure. In 2005, Spain, Germany, France, Italy and the United Kingdom were the main producers of aggregates, accounting for approximately two thirds of production in the EU-25. In addition, currently, there are over 22 000 production sites across Europe, each servicing local markets.

Figure 3.1 Environmental tax revenues by Member State and type of tax in 2005 (% of GDP)



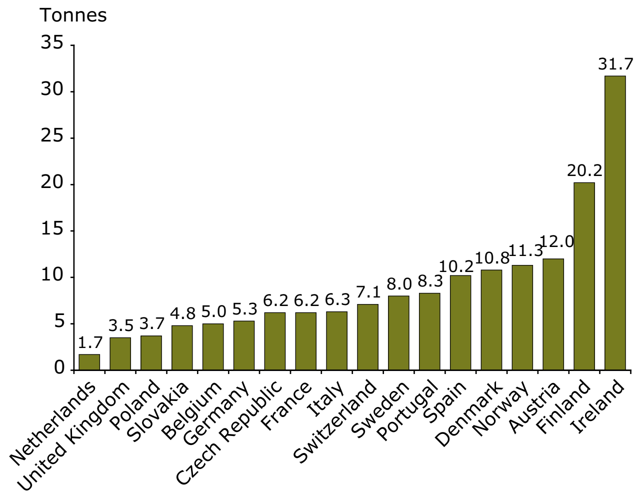
Source: Based on EC, 2007.

Figure 3.2 European production of primary aggregates in 2005



Source: UEPG 2006 (data of 2003).

Figure 3.3 Per capita production of primary aggregates in 2005



Source: Compiled on the basis of UEPG 2006 (data of 2003).

In contrast, the output of aggregates per capita per year shows a different picture. The average output is about 7 tonnes per capita. The leading countries in per capita output are Ireland (31.7 tonnes per capita) and Finland (18.5 tonnes per capita), whereas the main producers are below average (with the exception of Spain with 10.2 tonnes per capita).

The economic relevance of aggregates varies across EU Member States. Table 3.1 below compares the prospects for housing and construction markets in the context of today's situation of industrial supply. It also calculates the relevance of aggregates as a function of production per GDP per capita.

Table 3.1 Economic relevance of aggregates production and expected expenditure for construction per capita in Europe

Member State	Economic relevance * (average = 1)	Expected expenditure for construction per capita 2006–2008 in EUR
Slovakia	2.8	< 1 800
Poland	2.7	< 1 800
Ireland	2.5	> 3 300
Finland	2.4	> 3 300
Portugal	2.3	> 3 300
Czech Republic	2.2	< 1 800
Spain	1.9	> 3 300
Austria	1.5	2 800–3 300
Italy	1.0	2 300–2 800
Sweden	1.0	1 800–2 300
Norway	0.9	2 800–3 300
France	0.9	2 300–2 800
Germany	0.9	1 800–2 300
Belgium	0.8	1 800–2 300
Denmark	0.7	2 800–3 300
United Kingdom	0.6	2 300–2 800
Switzerland	0.4	2 300–2 800
Netherlands	0.1	2 800–3 300

Note: * Relevance calculated as production (t) per 1 000 EUR GDP per capita, average = 1.

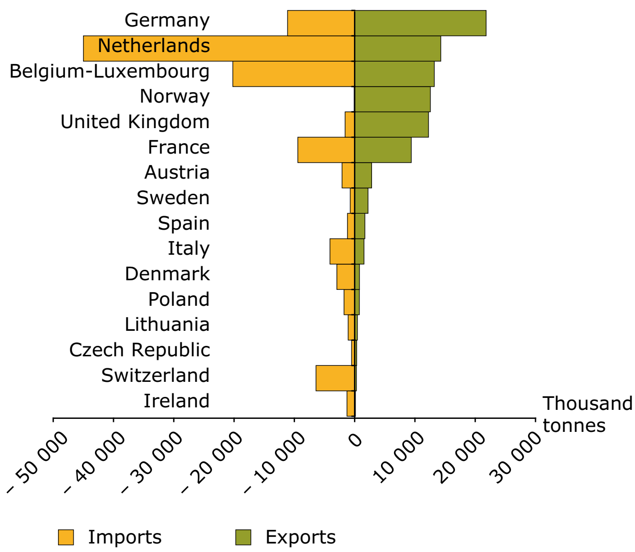
Source: Own calculations, on the basis of UEPG, 2005, Rußig, 2006.

Markets for aggregates are still predominantly supplied within a limited radius. The distance between operation sites and place of use is a key cost factor, due to the bulk weight of the material. For example, the tonnage of aggregates transported in Germany via freight vehicle amounts to 45 % of total goods transported (Bundesamt für Güterverkehr, 2006).

Transportation costs often limit the radius of quarrying sites to the area of larger towns. However, within Europe, there is evidence of the growing trade in aggregates. In 2004, main net importers were the Netherlands, Belgium, Luxembourg and Switzerland; the main net exporters were Norway, Germany and United Kingdom (see Figure 3.4).

Environmental taxes are applied in all European countries as a source of government revenues (EEA, 2005d, p. 40). Table 3.2 below shows taxes and charges related to aggregates extraction that are presently in force in Europe.

Figure 3.4 Imports and exports of primary aggregates in 2004



Source: British Geological Survey, 2006.

Pure aggregates taxes (including sand, gravel and/or crushed rock) are implemented in Denmark, Sweden ('natural gravel tax'), the United Kingdom ('aggregates tax'), and in Belgium (Flanders) and Italy — on a regional level. Other countries raise mining or extraction charges. Two forms of taxes have to be distinguished in general: ad valorem taxes (monetary tax base) and ad quantum taxes (physical tax base). Denmark and Sweden are examples for ad quantum taxes. Other countries, which rate the extraction of mineral raw materials ad valorem, are the Czech Republic and Poland (EEA, 2005d, p. 58).

Table 3.2 Taxes and charges on aggregates on national level

Member State	Name of tax, charge or fee	Purpose of instrument	Year of introduction
Belgium	Gravel levy (regional, Flanders)	Termination of extraction by 2010	1993
Bulgaria	Mining charge	No purpose stated	1997
Cyprus	Quarrying charge	No purpose stated	N/A
Czech Republic	Payments for mineral extraction	No purpose stated	1993
Denmark	Duty on raw materials	Efficient use of natural resources	1978
Estonia	Mineral extraction tax	Efficient use of natural resources/cost coverage	1991
France	General tax on activities causing pollution; extracted materials (granulates)	Cost coverage	1999
Germany	Mining charge (Laender level)	No purpose stated	1980
Hungary	Mining charge	Fundraising for mine redemption	N/A
Italy	Quarrying activities (regional)	Compensation for environmental costs	N/A
Latvia	Natural resources charge; materials extraction charge	Efficient use of natural resources/cost coverage No purpose stated	1996 N/A
Lithuania	Mineral extraction charges	Efficient use of natural resources/cost coverage	1991
Poland	Mineral extraction charge	Cost coverage	N/A
Slovakia	Mining charge	Revenue raising	N/A
Sweden	Mineral act charge; natural gravel tax; excavation charge	Cost coverage Efficient use of natural resources/cost coverage	1992 1996 1999
United Kingdom	Aggregates levy	Reduce demand of primary materials	2002

Source: OECD/EEA database/ETC/RWM, 2005.

4 Country studies

4.1 United Kingdom

Tax objectives and design

The UK aggregates ([19]) tax was introduced in April 2002 and justified by the presence of external costs of aggregates extraction. The tax is charged on quarry operators and other organisations that commercially exploit aggregates. It was introduced at a rate of EUR 2.35 (or GBP 1.60) per tonne, which equates to approximately 20 % of the average price per tonne of material. The basis for the tax was underpinned by a contingent valuation study ([20]) that estimated the total external costs of aggregates extraction in the region of EUR 558 (or GBP 380) million per year.

In the Budget 2007, it was announced that from 1 April 2008, the rate of the tax would increase to EUR 2.87 (or GBP 1.95) per tonne to take account of inflation since the introduction of the tax. Not all aggregates are subject to the tax — certain secondary aggregate materials, such as waste shale and slate, for example, are not taxable — and in certain cases, depending on what use the aggregate is to be put to, exemptions may apply. If the aggregate is to be supplied to people outside the United Kingdom, then the tax is refundable, and any aggregates imported from outside the United Kingdom become subject to the tax once they are commercially exploited.

The objective of the UK aggregate levy has been principally two-fold. The primary aim has been to reduce the environmental costs associated with quarrying operations, e.g. noise, dust, visual intrusion, loss of amenity and damage to biodiversity. Secondly, the tax aims to reduce the demand for aggregates and encourage the use of alternative materials, such as secondary aggregate materials exempt from the levy or recycled aggregate materials. Two additional policy measures were associated with the introduction of the aggregate levy.

- Revenues raised from the aggregates levy are recycled to business through a 0.1 % age point cut in employer NICs.

- Revenues are also recycled through an Aggregates Levy Sustainability Fund (ALSF) aimed at delivering local environmental benefits to areas subject to the environmental costs of aggregates extraction. The first objective of the ALSF is to reduce demand of primary aggregates through promoting the greater use of recycled and secondary aggregates.

The latter policy measure was specifically targeting the negative externalities associated with aggregate extraction. The UK approach of applying two policy levers (aggregate tax and ALSF) to correct market failures contrasts to the methods adopted by other EU Member States, which have typically introduced the tax instrument in isolation.

UK market overview

In 2005, the United Kingdom produced 275 million tonnes of aggregates, of which over 68 million tonnes came from recycled and secondary sources. Ninety per cent of all aggregates are used by the construction industry, both as end-products and as raw materials in the production of concrete, asphalt and mortar. However, aggregates purchases constitute only 2–3 % of construction costs. Furthermore, aggregates demand is significantly influenced by the decisions of the public sector, which is responsible for some 40 % of all aggregates use. Transport (road and rail) is the largest market for aggregate material in the United Kingdom, followed by private housing, commercial and industrial work.

The main conversion sectors include: cement, concrete, construction, plaster, agriculture, recycled aggregate, blast furnaces, DIY outlets, builder merchants, etc. Eighty per cent of aggregates are

([19]) Aggregates are defined as rock, gravel or sand and any materials naturally mixed with them.
([20]) London Economics, 1994.

used within 35–50 kilometres of their source. Beyond this distance, the material becomes uneconomic to sell due to the relatively high transport costs in comparison to the value of the product. The main exception is crushed rock aggregate delivered to the south-east, which travels 100 to 130 kilometres because, due to geological factors, there is no local source of rock.

Aggregate use is split for unbound use and bound use (concrete and asphalt). The actual split between unbound and bound is within 45–55 %. Substitutes relate to secondary material, such as waste slate and shale. The main aggregate extraction sectors in the United Kingdom include mining for sand, gravel, clay, rocks and slate. The geographical variation in aggregate extraction across the United Kingdom is illustrated in Map 4.1. The South-East of England has a significant proportion of total sand and gravel, whilst rocks and slate are scarce and need to be transported over large distances to meet demand.

The overall supply of aggregates is managed by a minerals planning system controlled by the Department for Communities and Local Government (DCLG). The aim is to keep supply roughly in line with demand, subject to environmental considerations. The market is dominated by seven companies who account for approximately 80 % of aggregates supply. At the other extreme, there exist over 350 companies producing small amounts of aggregates.

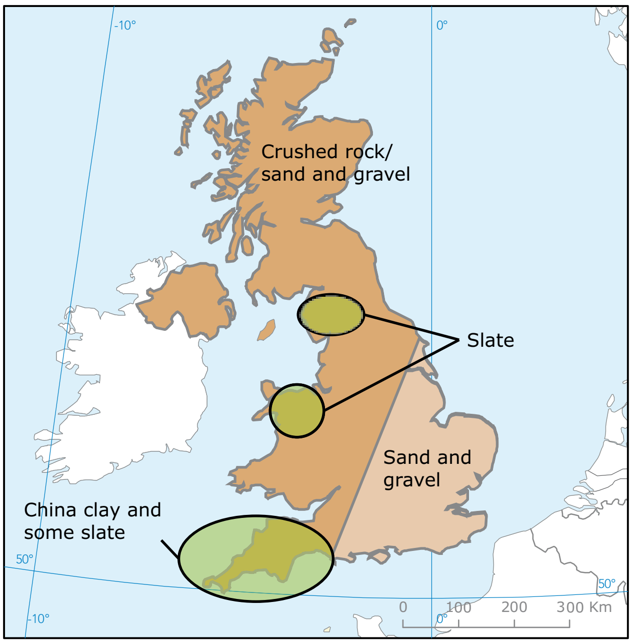
Main findings from the UK study

The production of primary aggregates in the United Kingdom has been falling since 1990. A number of factors that preceded the introduction of the aggregate levy have contributed to the decline in primary aggregates. These primarily include:

- the introduction of the landfill tax in 1996 has encouraged greater reuse of construction and demolition waste;
- a general decline in road-building over the period;
- lower intensity and improved use of aggregates in construction due to technical improvements, e.g. thinner high performance asphalt layers used in road construction.

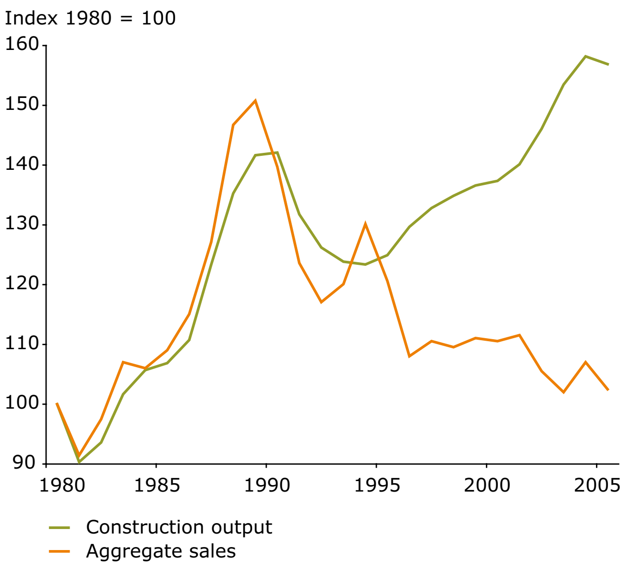
Figure 4.1 shows the trend in the production of construction aggregates since 1982, comparing it with the construction output. UK aggregates production had been increasing during the 1980s, and reached a peak in 1989 before falling in line with a drop in construction activity. Demand showed some recovery in 1994 when several major road schemes were completed, but then fell again in 1995 and 1996, due, in part, to the introduction of the landfill tax in 1996. The graph indicates that since

Map 4.1 Aggregate extraction across the United Kingdom, 2005



Source: HM Revenue & Customs.

Figure 4.1 Trends in construction output and primary aggregate sales



Source: UK Office for National Statistics (ONS) and Business Enterprise and Regulatory Reform Department (BERR).

the introduction of the aggregate tax in 2002, there has clearly been a further drop in aggregate sales, despite an increase in construction output.

Analysis undertaken by the Quarry Products Association (QPA) shows that the impact of introducing the aggregate levy has been most marked in reducing sales of low quality crushed rock, which they estimate to have fallen by 6 million tonnes. This has resulted in the substitution of lower quality taxed aggregates by waste streams from other non-taxed extracted minerals such as shale, slate and china clay. The QPA argue that much of this additional china clay and slate extraction would have taken place without the levy, as the by-product of premium china clay and slate production, and, as such, is not a substitution. They estimate that 1 million tonnes of these materials would have been extracted with or without the levy, so that the 'substitution' attributed to the levy is in the range of 2–3 million tonnes.

These figures are disputed by the Waste & Resources Action Programme (WRAP) who commented that slate and shale are only competitive within a small radius of production, and so the levy has had a limited impact. During the period from 2001 to 2005, aggregates from china clay waste and slate waste have increased by around 500 kt. This is mainly because the levy enabled deliveries to be competitive over a larger radius.

The levy has provided incentives that have modestly increased the demand and expanded the market for recycled aggregates. The QPA estimate that the supply of recycled and secondary materials was increasing by 2 million tonnes per annum before the introduction of the levy and this has risen to 3 million tonnes per annum after the levy was introduced. The latest figures for 2005 put recycled and secondary aggregates at 68 million tonnes and the total market at 275 million tonnes. Recycled aggregates, therefore, account for almost 25 % of the UK aggregates market, the largest recycled market share of any European country.

The most significant growth in recycled aggregate is within the construction and demolition waste stream which accounts for over two thirds of the total. Figures from the DCLG Survey (2005) of arisings and use of alternatives to primary extraction conclude that the production of recycled aggregates has risen from 39.6 million tonnes ± 13 % in 2003 to 42.07 million tonnes ± 15 % in 2005. However, they report that this change is not statistically significant. Evidence from the surveys suggests that the population of recycling crushers has continued to grow, but that the annual throughput of the average crusher has fallen since 2003, pointing to greater competition between recyclers.

New entrants have identified market opportunities in the recycling sector, which, in turn, has encouraged existing operators (aggregate producers and demolition companies) to diversify into the recycling market. Some companies have responded through innovation in recycling techniques introduced to capture new markets. WRAP commented that the overall growth in recycling has been predominantly in low performance applications. This has resulted in the displacement of some low grade primary aggregates and the subsequent increase in stocks of these materials at some quarries. However, investments by recycled aggregate producers are further increasing the product range into materials for concrete and decorative aggregates.

A number of activities funded by WRAP through the Aggregate Levy Sustainability Fund (ALSF) have made a contribution to the growth in recycling. Stakeholders attending the WRAP aggregates forum identified the types of contribution made. Those are:

(a) improved quality standards for aggregate that is recycled from waste. WRAP developed the Waste Quality Protocol which has significantly lowered barriers, such as stigma, attached to using aggregate waste materials and encouraged the expansion of the market;

(b) raising awareness and increasing end-user confidence by organising seminars to encourage local authorities to use recycled aggregate materials in local infrastructure projects;

(c) providing cheap access to capital for reprocessing infrastructure to increase quality supply;

(d) delivering accessible robust information, e.g. Aggregain web-based information service (www.aggregain.org.uk), which has over 260 registered users.

Neither government nor the industry have provided any evidence to show that the aggregate tax has resulted in reductions of the following: noise and vibration; dust and other emissions to air; visual intrusion; loss of amenity and damage to wildlife habitats. This is despite the tax being underpinned by a contingent valuation study that estimated the total external costs of aggregates extraction in the region of EUR 558 (or GBP 380 million) per year.

The Aggregate Levy Sustainability Fund (ALSF), using revenues from the levy, has been used partially to target the negative externalities from quarry activities. The ALSF has largely been distributed to English Nature, English Heritage, and WRAP. As a consequence, it has often been used to finance projects that compensate rather than mitigate quarry impacts. It is only over the past two years that more of the ALSF has been directed to local authorities with a greater emphasis on targeting benefits for local quarry communities.

Views are mixed on whether the aggregate levy has prompted an increase in transport of the aggregate materials. A 2005 report for the British Aggregates Association highlighted the fact that secondary aggregates, such as power-station ash and slag, that can be used in construction and which are not subject to the levy, become relatively cheaper and, therefore, more economically viable. Since the sources of these materials tend to be further from construction markets than the primary, taxed materials, there may be additional transport costs and externalities from moving the untaxed materials to the construction sites. However, any increase in transport of these secondary materials is likely to have been partially offset by a reduction in the transport of the recycled materials.

WRAP and the officials from ODPM (UK minerals planning body) have reported an increase in the use of mobile crushers for recycling aggregates. It provides access to local markets for building and construction work without the need to transport the material over long distances, e.g. demolishing buildings. It also makes it possible to produce recycled aggregates for use in new construction on the site. However, the QPA argue that mobile crushers are likely to have a bigger local environmental impact because, normally, these operations are taking place in more populated areas, and since often the recycled materials would be sold to other sites, it requires transport. It is, therefore, difficult to estimate the net environmental benefit.

There was an unintended trade effect caused by the levy. The proximity of Northern Ireland (with aggregate levy) to Ireland (without levy) led to a high level of illegal trade activity across the border. As a consequence, a tax credit of 80 % was introduced in 2004 and became available for all aggregates originating and exploited in Northern Ireland, conditional on operators signing an environmental agreement.

Main lessons from the UK study

In our assessment, based on interviews and reviews of published information sources, the aggregate levy has acted as a stimulus towards environmental improvements. However, it would be unfair to attribute the entire effect to the aggregate levy in isolation. It is the combination of policies that have given a signal to producers of the need to change production methods and practices.

The aggregate levy forms an important component of the policy package (which includes the ALSF and landfill tax); and it is the multi-level approach that creates strong incentives to which the aggregate industry has responded. The overall effect has been to encourage the substitution of primary aggregates for recycled construction and demolition waste, which creates a much lower environmental impact from energy use and carbon dioxide emissions.

From this assessment, a lesson can be drawn for other EU countries that may be considering introducing an aggregate tax. It is important to understand how a wider set of policies, in addition to the tax, interact with the aggregate system. The combination of a tax with other policy levers (e.g. permits, quality standards) introduced as a package of interventions is often more effective in delivering environmental improvements. The tax on its own may not be enough to correct the market failures, such as the environmental harm, caused by aggregate extraction.

The elasticity of demand needs to be considered before introducing a tax, since it determines how sensitive producers and consumers will be to a change in price (via the tax ([21])) and thus, how effective it will be. The nature of aggregate products, being of low value and homogeneous, makes them unprofitable to transport over long distances.

In relation to overall construction costs, the cost of aggregate materials is low, and so demand for aggregates is generally inelastic. Whether demand from the construction industry is met by recycled aggregates or primary aggregate materials is influencing the relative price between them. The cross-price elasticity between recycled and primary aggregates is an important consideration when

([21]) Taxes are essential instruments for internalising external costs. A Pigouvian tax = social marginal cost of pollution (marginal value of damage) –> socially optimal level of tax in the first-best world. The Baumol-Oates approach: environmental tax = marginal abatement cost corresponding to a given environmental target is the second-best option.

deciding the level and assessing the effect of the aggregate tax.

The aggregate tax can provide an important signal that the government is committed to changing the behaviour of producers and consumers of aggregate materials. In the United Kingdom, a proportion of the revenue raised has been used to correct market failures, e.g. training lorry drivers so that the transport of aggregates is more efficient and less disruptive. This has generally been perceived, both by the aggregate companies and communities affected, as generating benefits.

Tax distortions across country borders need to be considered when deciding the appropriate rate of the tax. The experience in Northern Ireland shows that a 'one size fits all' aggregate tax rate can lead to unintended effects, particularly where regions of a country have borders with tax differentials. This can lead to significant flows of illegal trade in aggregate materials, which become costly to monitor and enforce.

4.2 Sweden

Tax objectives and design

The Swedish gravel tax was introduced in July 1996 at a rate of EUR 0.53 (or SEK 5) per tonne, which corresponds roughly to a 10 % price increase on natural gravel. In 2003 the tax on natural gravel was raised to EUR 1.07 (or SEK 10) per tonne extracted gravel, primarily to increase the incentive effects. It was raised a second time in 2006 to EUR 1.38 (or SEK 13) per tonne.

Any company or body that exploits a site that requires a permit under the Swedish Environmental Code must pay the tax. However, activities within gravel pits and for aftercare at the site are exempt from the charge. Import penetration of the Swedish market is very low at 0.1 % and these are not charged the tax. Exports of sand and gravel are subject to the tax, although this is applied to low volumes and seeks to maintain supply on the domestic market.

The rationale for introducing the gravel tax was primarily environmental with concerns about resource scarcity, water quality and preserving the landscape. Gravel is regarded as an invaluable resource in Sweden since it is an important groundwater reservoir (i.e. aquifer) material, and in certain parts of Sweden gravel beds are essential for drinking water supply where natural gravel is used as a filter for purification of drinking or sewage water.

The Swedish EPA recognises that there is a great shortage of natural sand and gravel in many parts of Sweden. In fact, this shortage is occurring mainly in southern Sweden, and also parts of east and west Sweden. The Geological Survey of Sweden (SGU) estimated that natural gravel in Sweden, given the 1996 production level, would run out in 40 municipalities within 20 years. Conservation of natural gravel and material substitution were therefore the main reasons for introducing the tax.

An initial goal of the tax was to reach the proportions 30:70 between natural gravel and its substitutes, but no time limit was stipulated for when this should be attained. Another aim was that, before the year 2010, recycled material should have reached 15 % of total material used. These objectives were modified over time. In 1998 the Swedish Parliament specified a quantitative target, 'that the extraction of natural gravel should be less than 12 million tonnes by the year 2010'.

Swedish market overview

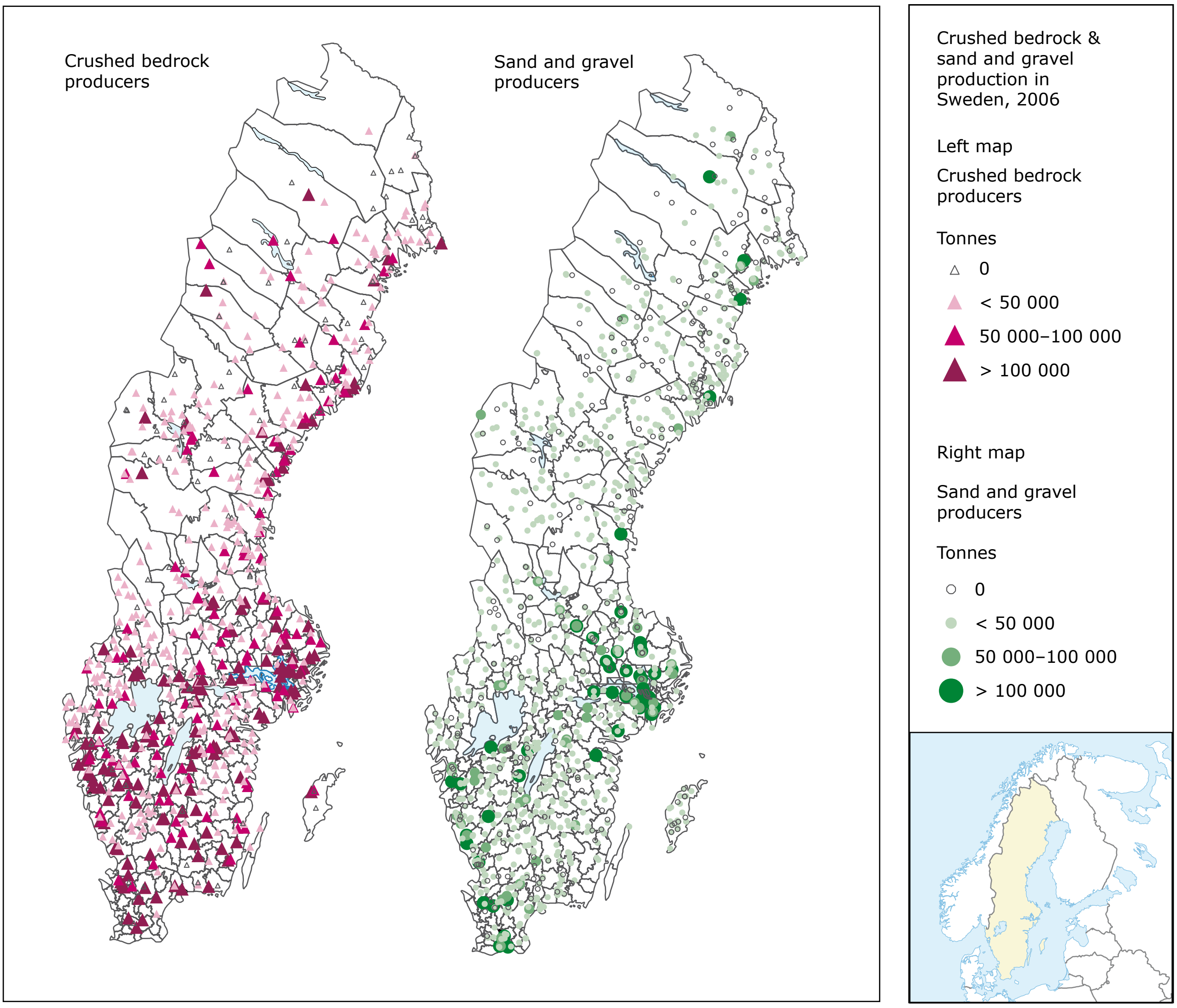
Sweden uses on average around 75 million tonnes of aggregates each year, of which only 8 million tonnes comes from recycled and secondary sources. The largest area of use is as construction material for roads, railroads and other infrastructure projects. Over half of aggregate production in Sweden goes to the construction of roads, with another major use being filling on farm land and landfill sites. The use of sand and gravel from natural deposits for each of these uses equates to 24 %. The average per capita consumption of sand and gravel from natural deposits amounted to 2.7 tonnes in 2004, however, this figure varies between counties (0.9 tonnes in the Östergötland county to 5.8 tonnes in the Jämtland county).

Deliveries of sand and gravel from natural deposits have decreased by almost 50 million tonnes over the last twenty years. Total sand and gravel supply stood at 25 million tonnes in 2004, compared to a crushed rock supply of 47 million tonnes.

Map 4.2 shows the distribution of crushed bedrock production compared to sand and gravel across Sweden. This illustrates the significant concentration of supply in the more highly populated southern and middle area of Sweden, particularly around the major urban cities of Stockholm, Gothenburg and Malmo.

The overall supply of Swedish aggregates is managed by the County Administrative Boards who issue the permits to extract aggregate material. The County Administrative Boards are required

Map 4.2 Crushed bedrock and sand and gravel production, 2006



Source: Geological Survey of Sweden (SGU).

to consider all of the local building plans for the region and estimate the total amount of aggregate material needed. A condition of the permit is that the extraction company must provide a study that analyses the need for a quarry and also provides a plan of how to restore the gravel pit or quarry at the end of the extraction period.

There is a limit set on the quantity of natural sand and gravel that can be extracted under each permit each year. On average it takes between 2–4 years to be issued with a permit, due to a lengthy consultation procedure. The Administrative Board has to review each permit request and consider issues such as transport distance and the need for a quarry in a specific locality i.e. check it is not in an environmentally sensitive area.

The Swedish government has ordered each of the County Administrative Boards to work towards a national environmental target so that, by 2010, the deliveries of sand and gravel from natural deposits must not exceed 12 million tonnes a year. All twenty-one counties have now formulated aims related to the national target.

Main findings from the Swedish study

Even before the tax was introduced (and even announced) the decrease in natural gravel production was significant. The development of aggregate deliveries over the time period 1984–2004 is shown in Figure 4.2. From 1996 to 2001, the natural gravel share decreased faster than for the period before the tax was introduced (Finansdepartementet, 2003).

There are a number of factors that have been cited as influencing this change:

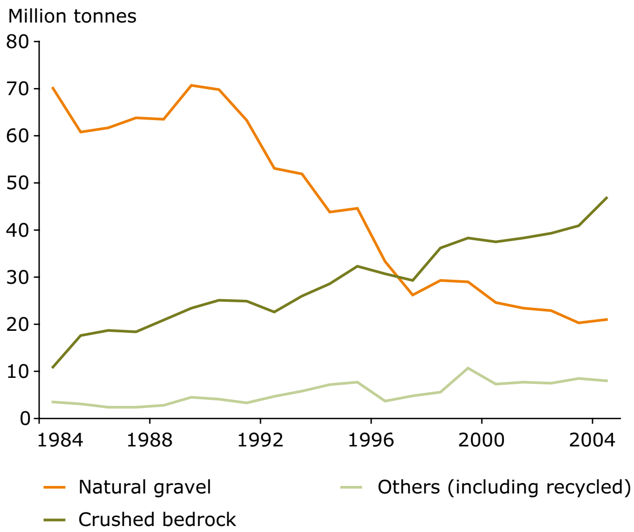
(a) road building material procurement changed after 1988 encouraging a shift in material use from natural gravel to crushed bedrock;

(b) permit allocations for gravel pits have been tightened over the period;

(c) consumer preferences have changed due to awareness of environmental impacts and they are increasingly demanding high quality materials.

The Swedish EPA undertook an initial evaluation three years after the gravel tax was introduced. This provided evidence that the gravel tax had a modest effect. Following the introduction of the tax the price of natural gravel increased and the proportion of natural gravel sold decreased by around 10 percentage points. A significant part of the tax was therefore passed on from suppliers to the purchasers of natural gravel and this provided an incentive to switch to alternative materials. In tonnes, a substitution amounting to 10 % corresponds to about 5.6 million tonnes in 1997 and 6.6 million tonnes in 1998. Thus, the Swedish EPA initially claimed that the gravel tax had an effect on the use of natural gravel and contributed to conservation of natural gravel.

Figure 4.2 Aggregate production in Sweden by type of material



Source: Geological Survey of Sweden (SGU).

More recent analysis undertaken in 2006 by the Swedish Geological Survey (SGU) using the latest gravel statistics shows no correspondence between the gravel tax and gravel production. The SGU commented that this does not mean that the tax has not affected the market, only that they have been unable to show a statistical effect. The results indicate that the government target of 12 million tonnes of gravel deliveries will not be achieved by 2010, suggesting that other policy levers will be needed if this target is to be achieved or alternatively the tax rate may need to be increased further.

More qualitative evidence of a substitution effect is provided by examining the applications for new permit licences. The Stockholm Administrative board commented that by 1997, only six months after the gravel tax had been introduced, they started to notice considerable rock quarry applications, implying a shift towards crushed rock products.

The substitution of recycled aggregate for natural gravel has not been as significant as the shift towards crushed rock. Recycling rates vary across the country with Stockholm and other major urban areas having higher recycling levels in comparison to the rural, more remote counties. An official in the Swedish Ministry of Environment reported that, 'recycling in Sweden is not easy, since it is not common for old buildings to be pulled down. In addition, there was an expansion in house and road building in the 1980s and so the current stock of infrastructure has a low replacement rate'.

The SGU commented that the main material used for recycling in Sweden is mining waste, primarily in the far north with little demand, and production surplus from the stone industry. Recycling from building and demolition waste is limited due to lack of material to recycle. Overall, the scope for substituting recycled aggregate material for natural gravel is limited. As a result the government decided to remove a previous 15 % national recycling target. Instead much greater emphasis is placed on the 12 million tonne target for gravel use, with recycling mentioned as one of a number of factors that can help to achieve this.

Main lessons from the Swedish study

In our assessment there is only very weak evidence to show that the gravel tax has had the intended effect of shifting demand away from natural gravel towards the use of crushed rock. It is important to recognise that there have been other contributory factors that have supported this, the most important being a change in road building material policy and a tightening of the permit regime. It would be wrong to assume that the gravel tax by itself was enough to address the environmental objective. The tax has made a contribution to achieving the target but it was part of a broader package of measures. The combination of instruments (tax, permits and regional targets) together with the involvement of industry and other local actors in the community were essential to secure long-term changes in behaviour.

Another lesson is the need to consider the overall effect of the tax and take account of potential unintended consequences. There is evidence to show that the substitution towards crushed rock has resulted in greater energy use from extraction, since crushed rock requires approximately three times more energy per tonne of material in comparison to natural gravel. This will have been partly offset by a fall in the aggregate transport distance and associated fuel usage, because natural gravel is transported on average longer distances than crushed rock. Another effect — the water protection capacity of gravel under ground — has been mentioned but is not yet taken into account. The lesson would be to look at environmental benefits of preservation and to take that benefit into account when any extraction tax is formulated.

The wider economic effects are also important and it has been shown that the tax made a positive contribution to employment, since more employees are needed to produce crushed rock compared with the same quantity of natural gravel. Ideally (from an economic efficiency perspective) the effectiveness of the gravel tax policy could be judged between the positive economic benefit of maintaining an inexpensive water purification process compared to the negative benefit of increasing energy usage in the extraction process. The wider employment benefits could also be incorporated into this overall assessment together with all other significant effects such as environmental improvements and transport factors amongst others

An interesting feature of the Swedish gravel tax has been the decision to gradually increase the gravel tax over time. This seems to have been effective at reinforcing the signal to producers and consumers of costs and need to shift away from natural gravel use. The Ministry of Environment commented that 'companies viewed the tax as an instrument that was likely to increase over time and so changed investment decisions. This 'signal effect' had a strong influence in changing company production plans'. The incremental tax rises have also helped to facilitate a gradual restructuring across the aggregate industry.

A final lesson is the way in which competition issues were considered prior to introducing the gravel tax. Although the tax supported the goal of maintaining natural gravel deposits in the southern part of Sweden (where natural gravel is scarce) it imposed costs in northern Sweden (where natural gravel is abundant). It could be argued that the decision to introduce the gravel tax has not been a cost-effective option for the North and distorted the market.

The Ministry of Environment confirmed that there had been a discussion preceding the introduction of the gravel tax as to whether regional differences should have been taken into account by varying the gravel tax rate across the country. In the end it was decided that the distortions e.g. transport of aggregates across county borders with different tax rates and administration costs such as enforcement, would outweigh the benefits.

A solution may have been to use some of the revenue raised by the gravel tax to compensate those communities in the North that were most affected for equity and social purposes. Interestingly all of the revenue from the tax is incorporated into the central budget and used to finance general government spending programmes.

4.3 Italy

Tax objectives and design

In Italy the application of the tax on sand, gravel and rock is decentralised and has been in operation since the early 1990s. There is no common national rate of tax being applied. Instead every region applies different rates at provincial and municipal levels, per cubic metre of sand, gravel and rock extracted. The revenue from the tax is accrued by the municipalities and legislation prescribes it is earmarked for 'compensatory investments' in localities of quarrying activity. In Italy the charge on aggregates is only one element of a very complex planning, authorisation, and regulation system related to quarrying activities. The effectiveness of aggregate charges cannot therefore be performed in isolation from the other features and working of the administrative system.

The study focuses on two large Northern regions, Lombardy and Emilia-Romagna, which together account for over 12 million inhabitants (21 % of the national total) and more than 22 % of national GDP in 2004. For these two regions, the quantity and quality of data provided by local administrations was sufficient to undertake an econometric analysis, which explored the role of charges and demand/supply drivers that influence the extraction levels.

Italian market overview

In 2004, the Italian aggregates industry was composed of around 1 796 companies operating across 2 460 sites. The average size of companies is smaller in Italy than the EU average and the market is more competitive. Total estimated production was 358 million tonnes of which sand and gravel contributed 220 million tonnes and crushed rocks 135 million tonnes. Aggregates represent around 54 % of total number of quarrying sites in Italy. According to the industry trade associate ANEPLA the next most important component, around 31 %, is ornamental stone, and in particular marble, of which Italy is one of the world's major producers and exporters.

Unfortunately no national data series exists for virgin aggregates extraction in Italy. Indirect estimates of extraction levels, based on the Italian NAMEA, indicate that the trend in quantities extracted has been increasing from 1997/1998, in line with the favourable trend in construction investment, however, this trend slowed in 2000–2001. There are no time-series on prices of aggregates in Italy. According to the industry, the prices published by Chambers of Commerce cannot be considered to be representative of the market, which is made up of many small direct private transactions, with highly variable conditions. For example, the opening of a new construction site can suddenly raise the price of aggregates in the local area. Interviews with industry suggests that the average price for aggregate materials had increased during the last few years and, at present, is in the range EUR 8–9 per tonne in Lombardy and around EUR 15 per tonne in Emilia-Romagna.

In 2002 Italy produced approximately 40 million tonnes of construction and demolition waste, mostly in the Northern regions, of which only 3.7 million tonnes was recycled in 2004 according to ANPAR. The potential for recycling is therefore under-exploited and constrained by economic, regulatory and organisational factors. From the economic point of view, recycled aggregates, mostly due to the presently poor recycling market organisation, are not competitive with virgin materials in terms of either cost and/or quality. The Italian construction industry has a clear preference for virgin materials and still largely distrusts recycled materials, except for specific uses, such as filling. Recent changes in technical specifications for recycled aggregates and of public works contracts are expected to boost demand in the future. The administrative, legislative, and planning system for quarrying in Italy is rather complex. Unlike other sectors, it reflects a significant decentralisation of responsibilities and procedures, including the definition and management of extraction charges.

In Lombardy, the legislation in force is Regional Law 14/1998. It includes regulation on planning, exploitation, monitoring and fines, information and data. Planning is based on a regional plan, which in turn is based on the provincial plans approved by the Region. Provincial plans include the identification of exploitable sites, quantity and quality of materials to be extracted, allowable exploitation techniques, and the final designation of the site when the materials are exhausted. These agreements include guaranteed payment of the annual charge to the Municipality, with a commitment to carry out implementation of, and payment for, restoration of the site when activity ceases.

The institutional setting in Emilia-Romagna is different. The legislation in force is Regional Law 17/1991. It provides guidelines for Regional territorial plans and the identification of inter-municipal extractive sites. The Municipal extraction plans establish which sites can be exploited, the criteria and methods of exploitation, and the conditions relating to restoration of the area after closure of the quarry. Quarrying activities are authorised by the Municipal mayors, based on an agreement between the owner and the Municipality levying the charges which includes a commitment to post-closure restoration. The information system relating to quarries and mines is the responsibility of the Regions.

In general the four main actors, i.e. the Region, the Province, the Municipality, and the site owner, are similar across the whole of Italy (20 regions in all). However, the rules vary on the following items: the level of extraction charge; what the revenues are used for; how they are distributed; and the requirements for site restoration. Not all regions, particularly those in the south, have well developed systems for planning, charging, inventory, etc. In some areas in the south of Italy, quarries, like landfills, become embroiled in illegal activities involving criminal organisations.

Main findings from the Italian study

Since the late 1990s, Bologna, specifically the Emilia-Romagna region, has experienced a significant expansion in construction investments (Figure 4.3). The domestic extraction of aggregate has expanded correspondingly and average prices have increased during the last few years. Net imports of aggregates, particularly gravel and crushed rock, have been increasing since the late-1990s, although this is still only a small amount (1 %) compared to total domestic extraction.

Extraction charges are not primarily aimed at reducing the quantity extracted or at promoting recycling. Instead their purpose is to contribute to the external costs associated with quarrying activities through financing land conservation investments implemented by municipalities and other institutions that share the revenues, which mostly accrues to municipalities.

Results from the analysis and interviews suggest that the effect of the extraction charge has been very limited. The level of tax is generally too low (around EUR 0.41–0.57/m^3) to have had any real effect on demand. Although there are regional variations, the value of these charges at national level can be estimated at EUR 110 million, which is around 5 % of the estimated turnover of the aggregate industry.

Extraction and supply of aggregates is mainly controlled by regional and provincial planning of quarrying and the quantities of extraction. The present environmental objectives of planning are generally aimed at minimizing external impacts, supporting sustainable management of landscapes, and providing multi-value public goods within the local area.

The use of recycled aggregates is at a very low level due a number of factors:

- low level of extraction charges and landfill taxes;
- preference of the construction industry for virgin materials (due to poor quality of recycled materials and relatively low price on primary materials);
- lack of investment in recycling facilities.

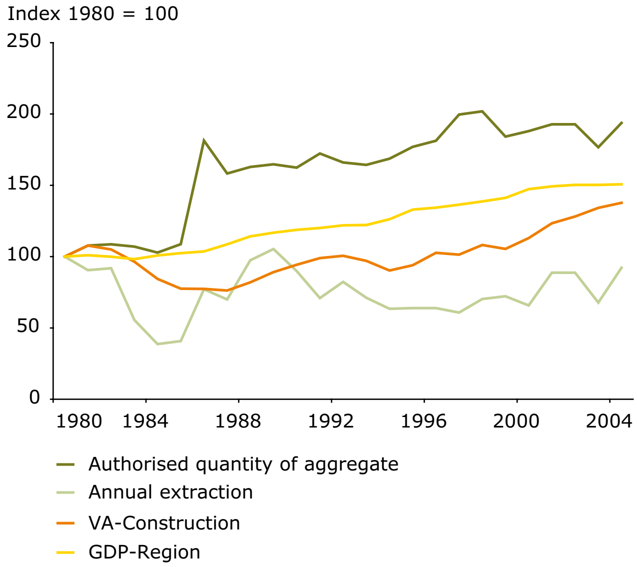
The econometric analysis of two large Italian regions, Lombardy and Emilia-Romagna, highlights the dominant role of demand drivers and the much more limited role of taxes/charges on extraction decisions. Although the 'decoupling' of extraction and GDP is occurring to a certain extent, this is not due to extraction charges.

It has not been possible to evaluate the use of revenue from the aggregate charge by the local administrations. There is no information on the use made by Italian municipalities of such revenue. However, qualitative information provided from interviews suggests that these funds are not invested in land resource conservation as much as might be expected. However, there are some good examples of the use of the funds. In some cases, funds are used to restore old quarrying sites, which in the past were not restored due to poor regulation and control.

In the Emilia-Romagna experience, the tax was initially conceived as a real environmental tax, based on the Polluter Pays Principle, aimed at correcting externality through a price-based measure. In the development of the policy, local administrators realized that the pure price instrument was not sufficient, and indirect effects, arising from tax integration into the whole planning system, were more important.

An indirect effect of introducing the aggregate tax has been to lead to an improvement in the quality of information arising from monitoring extraction activity. The requirement for the authorities to know exactly how much aggregates is extracted per year in order to calculate the tax made it necessary

Figure 4.3 Province of Bologna: aggregate extraction and drivers



Source: Bologna Statistical Office.

to have a very organized monitoring of activities at the quarry level. Prior to the introduction of the aggregate tax the monitoring was rather arbitrary or non-existent. The tax has therefore helped to encourage major changes in the management of extraction activities which now require:

- better knowledge and understanding of the activity, mainly in relation to construction of datasets, which have increased in quality and quantity since the mid nineties, to accurately record and elaborate the quarry data;
- the industry to take legal responsibility and declare the actual annual quantities extracted.

They must also show the extent to which operations meet the planning authorisations in terms of quantity, depth, distances from other sites etc. The administrative authorities then have a legal responsibility to check the accuracy of each firms' declaration.

The introduction of the tax has therefore led to much more accurate data on the amount of materials being extracted and increased the effectiveness and quality of monitoring activities. This has had the following additional benefits:

- The local administration gains a revenue stream from the aggregate tax. This has encouraged officials to increase their attention on this sector. Prior to the introduction of the aggregate tax, illegal and badly managed excavations were classed only in terms of environmental damage now they represent a loss of public revenue.
- Firms whose market behaviour is good have begun to collaborate with the local administrations to help them identify illegal excavations, since the latter's avoidance of tax produces unfair competition in the market.
- There has been a small reduction in the amounts of aggregate extracted, but in other respects there have been real improvements in the sector, both on the side of the public authorities and the market including a reduction in the number of operating quarries

Overall, the combination of direct and indirect effects linked to planning, monitoring and agent behaviour described above have generated multiple improvements in the way the system works in terms of efficiency, environmental performance, and quality of operators.

Main lessons from the Italian study

Italy has not discouraged extraction through high tax-based mechanisms and there is not a widespread perception of scarcity of aggregate as materials. Instead the strategy has been to allow extraction to grow in response to demand although under conditions that minimise the impact on land resources. The key incentives consist of the internalisation of local external costs in the cost structures of quarrying activities. This approach seems to encompass a 'weak sustainability' rule, according to which reduction in natural capital due to quarrying is compensated for by investments in natural capital in the surrounding areas, and investment is internalised in quarrying production costs through the charges levied.

The main limitations to such an approach come from: (a) the complexity of the administration required, which could produce a loss of correspondence between the costs of quarrying activities and the actual use of financial resources by local administrations; (b) the limited incentive to recycle arises from the low level of charges together with the exclusion of recycling costs from those charges. Despite these shortcomings, the Italian approach serves as a useful model in situations when high value is attached to the externalities supported by the land resources surrounding quarrying sites.

However, the Italian model will only be successful if the planning system is well managed. The quality of the administrative processes, in particular a proper earmarking of the revenues from charges, are a critical condition for effective results. The indirect benefits of improved monitoring and data quality generally support of this approach.

4.4 Czech Republic

Tax objectives and design

In the early 1990s the Czech Republic introduced charges that were applied to the volume and area of extracted minerals. The system was originally designed with a prominent focus on strategic raw materials such as coal, metals and high quality mineral ores. In 2002 the scope of the charge was extended to include aggregate materials. The area charge is equivalent to EUR 3.6–36 (or CZK 100–1 000) per km^2 per year, in accordance with local conditions and the impact to the environment, which is negligible in comparison to the total costs of a mining company'. The beneficiaries of this charge are municipalities on whose territories the mining activities take place.

An additional charge is levied on the volume of extracted material, calculated as a proportion of the sale price on the market. In case of the aggregates the rate is 2 % for construction stone and 3 % for sand and gravel. Thus, in total figures, the actual charge per one tonne of an aggregate material is roughly about CZK 3 (EUR 0.1). Beneficiaries of this charge are split between the municipalities (75 %) and the state budget (25 %). The total annual income from this charge is estimated at CZK 60 million (EUR 2.1 million).

There is a legal difference between the reserves over which the state claims exclusive rights, called 'reserved deposits' and those that belong to the owners of the land, or so called 'non-reserved' deposits. This originated from when the state carried out extensive geological surveys of mineral deposits that were considered of strategic economic importance. Only 'reserved' deposits, equivalent to about one third of total aggregates production, are subjected to the aggregate charge.

It should be noted that a reform of the charging system is underway in the Czech Republic. The aim is to shift the area charging system to a more ecological based instrument ([22]). The findings in this study reflect the data and experiences associated with the original per area charge calculation.

Czech market overview

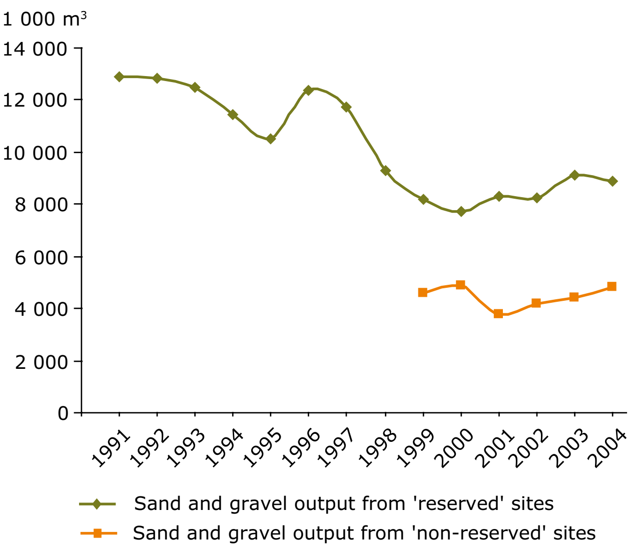
In terms of general economic activity of the Czech Republic, GDP growth has fluctuated considerably during the 1990s. The transition from a centrally planned to more market-based economy was accompanied by significant structural changes; including a fall in the industry and mining sectors and expansion in services, the public sector and transport.

Figures 4.4 and 4.5 show a significant drop in the sales of aggregate materials in the four years preceding 1993. This was mainly caused by the 1990–1992 recession when GDP fell by more than 12 %. However, aggregate sales have never recovered to former levels, despite there being no charges on aggregates in place.

The significant drop in aggregate production and sales can be attributed to two major causes:

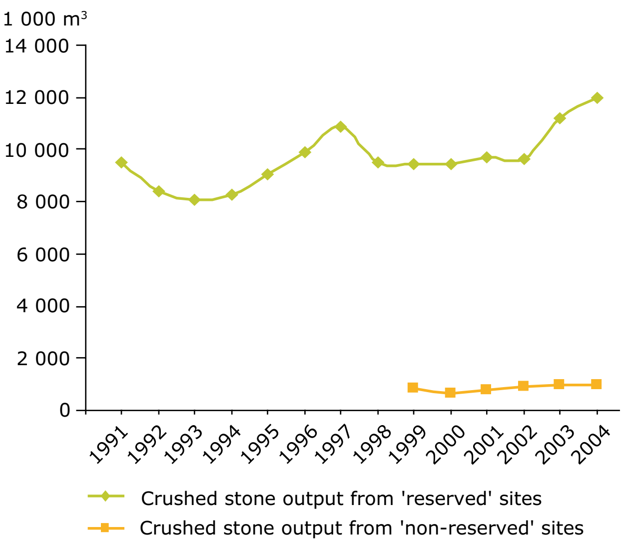
- First, enormous slump in demand for aggregates associated with the abandonment of the socialist model of development which tended to favour large-scale construction works and material intensive developments such as hydro-dams and large housing estates.

Figure 4.4 Trends in sand and gravel outputs in Czech Republic



Source: CSU, 2004.

Figure 4.5 Trends in construction stone outputs in Czech Republic



Source: CSU, 2004.

([22]) The new 'ecological' calculation model is not expected to have a major impact on the overall rates applied at most of the extraction sites.

- Second, the introduction of the market economy quickly led to a reduction in uneconomic and wasteful practices that had been typical for the socialist style of management.

The use of the recycled demolition and construction wastes remains relatively low in the Czech Republic and is estimated at around 10 %. The recycling industry faces strong competition from the virgin material producers and also the use of cheaper substitute secondary waste materials produced outside of the aggregates sector. For example, ash generated as a by-product from the energy sector is converted into a substitute for aggregates used in construction projects.

Generally the link between the aggregate consumption and construction and demolition wastes reuse is only weakly recognised as a concern by the public. Landfill is still the cheapest and dominant form of waste disposal in the Czech Republic. Construction and demolition wastes are not considered to be of a high environmental priority issue in comparison with municipal and packaging wastes.

Foreign trade in aggregates is negligible; with the overall annual export of aggregates remaining around 1 % of the total domestic production of the Czech Republic. This is mainly due to transport costs which make it uneconomic to transport materials long distances. Most of the trade is located close to the borders or where water-ways reduce the transport costs.

Approximately 4 000 people are employed in the quarrying of sand and gravel, construction stone and limestone. This constitutes about 0.1 % of the total employment of the Czech Republic and about 6.2 % of the employees working within the mining sector. As many of those jobs are in small facilities scattered in the rural areas, they are often considered to be important for local communities.

Firms that carry out prospecting, survey or extraction of reserve deposits or other mining activities are obliged to create financial reserves to cover remedial work and mining damage. The financial reserves constitute the main tool of environmental protection within the current system. Companies must also create a fund during extraction (which typically includes an amount for each tonne extracted) to cover the cost of restoration at the end of the life of the mine. The Czech Mining Authority is an independent executive body responsible for the direct supervision of the mining activities. Its regional branches supervise the individual mining sites and compliance with all relevant provisions, including the management of the reclamation plans and related funds. It also collects the charges from the extracting companies and transfers the money to the beneficiaries, both municipalities and the state budget.

Main findings from the Czech study

The low level of charge on aggregates has not had any observable effect on the quantity of materials being extracted since its introduction. Instead the main drivers have been from the growth in demand from the construction sector as the Czech economy restructures.

A variety of subsidies and subsidized loans have been introduced to encourage an expansion in individual and municipal housing which requires increasing quantities of aggregate materials. Several road and major infrastructure projects are being planned but the increase in resource-use efficiency by raising the cost of aggregates materials is not a politically favoured approach. This view was confirmed by stakeholders who felt that the aggregate charges did not have any influence on the intensity of material use in the construction sector. Aggregate products have a relatively low demand price elasticity so the increase in price would need to be significantly higher than the current rate of CZK 3 or EUR 0.1 per tonne to have any effect.

The low level of charges has also not influenced recycling rates. The relative competitiveness of recycled aggregates with respect to virgin materials has not changed significantly and as result, consumption patterns have remained unaffected. In addition, landfill costs are relatively low and construction and demolition waste is not seen as a major environmental concern.

The aggregates charges have not had any effect on energy use and transport distances either. Transport costs are a major component of total cost for the aggregate industry and are estimated to average CZK 25–30 (approx. EUR 1) per tonne per kilometre. This cost factor is much more significant in comparison with the current rate of the mining charge.

Stakeholders were of the opinion that a main benefit of the charges was to have improved relations between the extracting industry and local administrations and communities. The local budgets had directly benefited from the presence of mining activities in their vicinity.

The obligatory financial reserve fund that each company has to raise and maintain during the site operation is perceived as an excessive burden by the mining companies. The financial reserve is only allowed to be used or the reclamation of the site after the termination of the extracting activity and is the main tool for ensuring environmental protection.

Main lessons from the Czech study

The aggregate charges have been set too low by the authorities to have had any significant impact on the actual behaviour of the mining companies or other stakeholders. In addition, municipalities, as main beneficiaries of the system, are not obliged to use the money raised from the charge for environmental purposes.

Distortions in production have resulted from the policy to only apply the charges on 'reserved' deposits. This has contributed to a shift in production from 'reserved' to 'non-reserved' sites, although not at a rapid pace. The most significant achievement has been the reduction in numbers of operating quarry sites. However, this has not been accompanied with a reduction in the quantity of aggregates since this has taken place at sites which were already out of operation or with production close to zero.

The current system for calculating the aggregate charge is too complex. The change in legislation which revises the basis for a mining charge to reflect the ecological impact has been slow in implementation. It has generally been recognised, both by industry and government officials, that the change in the tax base is increasing the complexity, due to the multifaceted formula that is being used to calculate charges at different mining sites. General objections raised by various state bodies and corporate stakeholders point at the excessive complexity of the proposed arrangement since these would require detailed assessment of the individual sites, including gathering or creating of detailed map documentation and related material. The complexity and ambiguity of the provisions also allow for misinterpretations and leave the opportunity for various non-transparent practices.

5 Country comparison

5.1 Comparison of countries evaluated in the study

The starting point is to consider the context of the tax or charge in each of the study countries and compare the original objectives, coverage of the tax and the tax rate. It is interesting to note the differences between the original objectives for introducing the tax on aggregate materials. In Italy and the United Kingdom the objective of the tax was to target the environmental externalities associated with quarry activity. This differed to the objectives in Sweden and the Czech Republic where the tax was aimed at preserving the landscape and maintaining resources, see Table 5.1.

The application of the aggregates tax or charge differed across the countries. In the Czech Republic the charge was based on a combination of the area of land above the surface that was being exploited and also the volume of material that was produced. Italy taxed the volume of material extracted whilst Sweden taxed the tonnage of material. The United Kingdom introduced a sales tax on the weight of material sold from the quarry site. Exclusions also applied in some of the countries, for example

Table 5.1 Context of tax or charge

	Czech Republic	Italy	Sweden	United Kingdom
Objective of tax or charge	1) To raise revenue 2) To encourage deep mining and preserve the landscape.	1) To compensate for the environmental costs caused by quarry activity e.g. preserve natural capital 2) To preserve landscape	1) To safeguard gravel resources and water quality 2) To preserve the landscape	1) To compensate for environmental externalities caused by quarry activity 2) To reduce demand for aggregates and encourage recycling
Coverage of tax or charge	Applied across all mining activity Only reserved deposits subject to the tax	Applied to sand, gravel, ornamental stones, crushed rock	Applied to natural gravel = sand, gravel and cobbles	Applied to rock, gravel and sand
How the tax or charge is applied	Area based and charged per cubic meter	Charged per cubic meter	Charged per tonne extracted	Charged per tonne sold
Tax or charge rate on aggregates	EUR 0.1 per tonne	Varies by region EUR 0.2–0.3 per tonne	EUR 1.43 EUR per tonne	EUR 2.4 per tonne
Tax as % of aggregate price	2–3 %	4 %	12 %	20 %
Total revenue raised from tax	EUR 1.4 million	EUR 117 million	EUR 22 million	EUR 454 million
Aggregate tax revenue as % of total tax revenue	0.6 %	Not available	0.02 %	0.1 %
Administrative cost of tax	Not available	Not available	EUR 0.38 million per year	EUR 1.5 million per year

Sweden only applied the tax on natural gravel, whilst the United Kingdom excluded certain secondary aggregate materials such as waste slate and shale.

The tax rate ([23]) also varied considerably across the countries. The Czech Republic and Italy had very low rates of tax or charges which were below 4 % of the average price of aggregate material. In contrast the United Kingdom introduced an exceptionally high tax rate of 20 %, which equated to a fifth of the price of the materials. Sweden gradually raised the tax on natural gravel over a period of time to reinforce the signal to producers and facilitate a gradual restructuring within the sector, however, the tax in Sweden remains considerably lower than the tax rate applied in the United Kingdom.

The revenues raised by the tax were influenced by both the tax rates and the quantity of material being produced. Interestingly the revenue from the aggregate tax as a proportion of total tax revenue was particularly low and stood at just 0.1 % in the United Kingdom, even though it had the highest tax rate.

The differences in market structure across the countries are highlighted in Table 5.2. Italy has by far the greatest number of companies and sites operating in the aggregate sector, suggesting that the industry is highly competitive. In contrast the United Kingdom and Sweden have much fewer and a small number of firms have a significant market share. For example in Sweden the market is dominated by a few very large operators with around 10 % of the firms producing almost 70 % of the total of aggregates.

Italy and the United Kingdom produce far greater quantities of aggregate materials than Sweden and Czech Republic. This reflects the larger populations in these countries and the subsequent demand for housing and infrastructure that requires significant amounts of aggregate materials. Sweden has the highest aggregate production per capita, whilst the United Kingdom has the lowest. This can partly be explained by the geography of Sweden which requires long road and rail networks to be built and maintained despite a relatively small population. It contrasts to the United Kingdom which has a much larger number of densely populated cities.

The United Kingdom also has the highest recycling rate of aggregate materials whilst Italy and the Czech Republic have very low rates. This is largely due to a strong consumer preference for virgin aggregate materials and a lack of awareness or confidence in the performance of recycled materials within these countries.

5.2 Factors influencing the use of aggregate materials

Each of the country studies undertook a PEST analysis that examined the political, economic, social and technological factors influencing the use of aggregate materials. This considered the dynamic effects impacting on the system prior to the introduction of the tax, which provided a 'baseline assessment' of key factors impacting on the use of sand, gravel and rock materials.

Within each of the broad categories of the PEST a number of sub-factors were assessed in relation to whether they exerted a strong, moderate or weak influence on the use of aggregate materials in the country being studied. The level of influence for each factor provides an indication of the relative strength or weakness compared to the other

Table 5.2 Aggregate market comparison

	Czech Republic	Italy	Sweden	United Kingdom
Companies operating and number of sites	300 companies operating on 520 sites	1 796 companies operating on 2 460 sites	170 companies operating on 1 940 sites	350 companies operating on 1 280 sites
Total production	50 million tonnes	355 million tonnes	75 million tonnes	275 million tonnes
Total recycled	2.5 million tonnes	3–3.7 million tonnes	8 million tonnes	68 million tonnes
Tonne aggregates per capita	5.1	6.1	8.3	4.8

Source: UEPG.

([23]) Defined as the tax per unit of the materials covered by the tax base (i.e. weight, area, volume).

countries included in the study at a national level. The ratings are not intended to provide a precise score, but instead reflect a judgement based on the quantitative and qualitative evidence collected during the study. It is expected that due to the nature of aggregate markets, which typically serve local communities, the results may vary at a regional and local level.

Political factors influencing the use of sand, gravel and rock (Table 5.3)

Planning rules and road building policies have both consistently had a strong influence according to all of the countries studied. Building policy, often at a more local level, also has a decisive impact. Political decisions to tighten or loosen planning controls have had a major influence on aggregate producers' ability to obtain the permission to expand production. In addition, environmental obligations contained within planning application rules have improved restoration and remediation of quarry sites at the end of their life.

There has been limited earmarking from the revenue generated by the aggregate tax or charge. The United Kingdom is the only country that has established a specific Aggregate Sustainability Levy Fund (ASLF) which aims to improve the environmental performance of the sector. In Italy there is insufficient evidence to determine whether local municipalities actually used the revenue for environmental measures, whilst in the Czech Republic and Sweden the revenue is largely subsumed within national budgets.

Table 5.3 Political factors influencing the use of sand, gravel and rock

	Czech Republic	Italy	Sweden	United Kingdom
Planning rules	Strong	Strong	Strong	Strong
Environmental objectives	Weak	Moderate	Strong	Moderate
Road building policy	Strong	Strong	Strong	Strong
Business regulation	Strong	Moderate	Moderate	Moderate
EU legislation	Moderate	Moderate	Moderate	Moderate
Aggregate tax revenue	Weak	Weak	Weak	Strong
Other taxes (e.g. landfill)	Weak	Weak	Weak	Moderate
Other subsidies (e.g. housing)	Moderate	Weak	Weak	Weak
Trade/lobby associations	Weak	Weak	Moderate	Moderate

Notes: = Strong influence = Moderate influence = Weak influence

Table 5.4 Economic factors influencing the use of sand, gravel and rock

	Czech Republic	Italy	Sweden	United Kingdom
Concentration of industry	Weak	Weak	Strong	Strong
Material substitution (inputs)	Weak	Weak	Strong	Moderate
Substitution (end use)	Weak	Moderate	Moderate	Moderate
Transport costs	Strong	Strong	Strong	Strong
Access to capital	Weak	Weak	Moderate	Strong
Nature of contracts	Weak	Weak	Weak	Strong
Trade	Weak	Weak	Weak	Weak
Economic growth (GDP)	Strong	Strong	Strong	Strong
Energy prices	Strong	Strong	Strong	Strong

Notes: = Strong influence = Moderate influence = Weak influence

Economic factors influencing the use of sand, gravel and rock (Table 5.4)

Each of the countries reported a strong influence on aggregate use from construction activity, which is often correlated with economic growth, although the construction cycle is sometimes boosted or slowed down by public policies. Energy prices were another factor that had a strong influence due to the impact on production and transport costs. The transport of bulky aggregate materials constitutes a significant proportion of the total cost, making it uneconomic to transport over long distances. The high transport costs also influence the viability of using substitute materials which need to be close to the market to compete.

The substitution of aggregate input materials has been strongest in Sweden where there has been a significant shift in the use of crushed rock replacing gravel. This trend preceded the introduction of the natural gravel tax. The United Kingdom has also seen a modest substitution towards the use of recycling and secondary aggregate materials, although there is not yet sufficient data to show whether this has been caused by the introduction of the aggregate levy.

Social factors influencing the use of sand, gravel and rock (Table 5.5)

There are a number of social factors that influence the demand for aggregate materials. Both the United Kingdom and Italy have high population densities that require significant quantities of sand, gravel and rock for building housing and infrastructures. In addition, countries with low and spread out population densities, such as Sweden, require significant amounts of aggregate materials for road construction and transport. Social preferences also exert a pressure through the design and composition of building structures. Italy has reported a preference for the use of stone instead of concrete; Swedish households desire wooden external structures; UK homes are traditionally made from brick and office buildings are shifting away from concrete and using brick, glass and steel to provide a more modern design.

Meanwhile, societal concern varies considerably across the countries. The Czech Republic has a much greater focus on economic growth and the need to provide construction materials for new housing and infrastructure is a primary societal concern. In Italy, Sweden and the United Kingdom the importance of the issue is mixed reflecting regional and local concerns. For example, in Sweden the cities in the south of the country have a much greater awareness and concern about natural gravel scarcity since it has a direct impact on the water quality in that area. This is similar to the response in Italy where the industrialised north has greater concerns than the rural southern region of the country.

Technical and geological factors influencing the use of sand, gravel and rock (Table 5.6)

The natural geology of each of the countries influences the availability of aggregate materials to local markets. The Czech Republic has an abundant quantity of sand, gravel and rock across the whole country so the influence on supply of aggregates is relatively weak. In contrast, the United Kingdom and Sweden have strong regional variations in the quantity of aggregate materials available. The South East of England has plenty of gravel deposits. However, in this region there is no rock which must be transported from the west or north of England. In Sweden the scarcity of natural gravel is greatest in the South and middle of the country, particularly around the cities of Gothenburg and Stockholm, whereas in the Northern territories natural gravel is abundant. In the northern regions that were studied in Italy there is a mixture of availability dependant upon locality.

Technical requirements have exerted a strong influence in the United Kingdom where waste quality protocols for the reuse of construction and demolition waste have helped to overcome the stigma attached with using recycled aggregate

Table 5.5 Social factors influencing the use of sand, gravel and rock

	Czech Republic	Italy	Sweden	United Kingdom
Population density	Weak	Strong	Moderate	Strong
Social preferences	Weak	Moderate	Moderate	Moderate
Societal concern	Weak	Moderate	Strong	Moderate

Notes: = Strong influence = Moderate influence = Weak influence

Table 5.6 Technical and geological factors influencing the use of sand, gravel and rock

	Czech Republic	Italy	Sweden	United Kingdom
Geological factors	Weak	Moderate	Strong	Strong
Level of investment in R&D	Weak	Weak	Weak	Moderate
Technical requirements	Weak	Strong	Strong	Strong
Access to start-up capital	Weak	Weak	Moderate	Moderate

Notes: = Strong influence = Moderate influence = Weak influence

materials. It has had the additional benefit of encouraging a greater level of investment in recycling research which has promoted innovation in the aggregate and recycling industry. In Sweden a change to the technical standards for inputs used in road building have led to a dramatic shift from gravel towards crushed rock, encouraging a high level of material substitution. In Italy and the Czech Republic the opposite effect has been recorded where the technical specifications of quarrying activities are strong, particularly by engineers in making procurement contracts.

5.3 Effects of the tax in relation to the national objectives

Each of the country studies undertook an analysis of the effect of the tax in relation to the national objectives. Further details of the methodological approach used to undertake this assessment can be found in Annex 1. The tables below summarises the results from this analysis and show the effects of the tax in relation to the national objectives. They describe what actually happened as a result of introducing the tax or charge on aggregates.

Table 5.7 Effect of tax in relation to national objective: reduce environmental externalities

Objective: to reduce environmental externalities (*)	
Czech Republic	*Not a national objective.*
Italy	No evidence to show that tax has had any effect in either of the two regions included in the study (Lombardy and Emilia-Romagna).
Sweden	*Not a national objective.*
United Kingdom	No quantitative data available to show any improvement, due to a lack of any measures in place. Neither government nor industry provided any evidence to show that the aggregate tax resulted in reductions in noise and vibration, dust and other emissions to air, visual intrusion, loss of amenity and damage to wildlife habitats.

Note: * Environmental externalities relate to noise, dust, pollution generated through quarry activities.

Table 5.8 Effect of tax in relation to national objective: preserve the landscape

Objective: to preserve the landscape	
Czech Republic	Interviewees in the Czech Republic confirmed that there had been a modest reduction in the number of operating quarry sites leading to an improvement in land use in these areas. However, this has not been accompanied with a reduction in the quantity of aggregates since this has taken place at sites which were already out of operation or with production close to zero. There was a lack of evidence to show that the tax had any effect in discouraging deep mining and preventing the spread of surface activity.
Italy	It was not possible to evaluate in detail the use of revenue from the aggregate charge by the local administrations, however, it was reported that the revenue was often used for land conservation investments, e.g. restoring old quarry sites not restored in the past.
Sweden	Strong evidence of the shift from gravel pit extraction to larger numbers of rock quarries. This was associated with preserving gravel mounds as a natural feature.
United Kingdom	*Not a national objective.*

5.4 Unintended effects of the tax

In addition to the intended effects of the tax, the country studies identified a number of unintended effects that were reported as having occurred following the introduction of the tax. These are summarised in Table 5.10.

5.5 Effects of the wider policy environment on aggregate extraction

A number of wider policy factors were also highlighted in reports or from interviewee comments, as influencing aggregate extraction decisions. The relative effect of the wider policy instruments were examined in each country to determine whether they have been supportive of the tax in reducing levels of extraction activity or encouraging an expansion in recycling with the results itemised below.

The Czech Republic has a primary objective to promote economic growth and improve housing and infrastructure. The study was unable to find any supportive effects from the wider policy environment to encourage a reduction in extraction. Indeed the high technical standards required and which are imposed on recycled materials actually created a disincentive for their use.

In Italy the planning system exerts a strong influence on the extraction of materials. The supply of aggregates is mainly controlled by regional and provincial planning of quarrying and extraction quantities. The present environmental objectives of planning are generally aimed at minimizing external

Table 5.9 Effect of tax in relation to national objective: reduce demand for aggregates and encourage recycling

Objective: to reduce demand for aggregates and encourage recycling	
Czech Republic	*Not a national objective.*
Italy	*Not a national objective.*
Sweden	Tax level has gradually increased over time. This has acted as a signal to producers and facilitated a gradual restructuring process. Analysis by Swedish Geological Unit is inconclusive as to whether the shift from gravel to crushed rock is caused by the tax. Ministry of Environment view was that the tax has helped to sustain the shift as part of a package of policy measures, such as tightening the permit regime.
United Kingdom	Analysis undertaken by HM Revenue and Customs indicates a slight reduction in aggregate sales following the introduction of the aggregate tax. However, there was a lack of data to show a significant result. Industry research shows a modest substitution to alternative 'untaxed' secondary waste materials e.g. slate, shale, china sand. Research undertaken by the Waste Resources Action Programme provides evidence of an increase in recycling activity which they predicted to continue to expand in the future.

Table 5.10 Unintended effects of tax

Unintended effects	
Czech Republic	Complexity of administrative process is a weakness e.g. reserved versus unreserved sites. New proposal for ecological tax formula expected to lead to extra complexity.
Italy	Uncertain whether revenue from tax is used exclusively for environmental purposes. An indirect effect of introducing the tax has been to lead to an improvement in the quality of information arising from monitoring extraction activity.
Sweden	Increased transport and energy use by substitution of gravel for crushed rock, which requires more energy per tonne extracted. Regional variation in gravel scarcity is not reflected in the tax which penalises the North where gravel is not scarce.
United Kingdom	Claims by industry that secondary aggregate waste materials not subject to tax e.g. shale, waste slate, china sand have been transported over longer distances. Industry complained about stockpiles of aggregate waste material build up on site, which impacts on landscape. Northern Ireland experienced aggregate materials trade distortion across the border, due to no tax in Ireland.

impacts, supporting sustainable management of landscapes, and providing multi-value public goods within the local area.

The Swedish study highlights the importance of recognising other wider contributory factors that have supported the shift from natural gravel use to crushed rock. The two most significant policies have been the change in road-building material standards and a tightening of the permit regime. Both of these policies have had a strong effect on the type of extraction and facilitated a restructuring in the industry towards crushed rock. The setting of clear environmental targets that were communicated from national to regional and local municipalities is another wider policy measure which has supported this change.

The United Kingdom study identified a number of factors that contributed to the decline in the use of primary aggregates. These included: the introduction of the landfill tax in 1996 which has encouraged greater reuse of construction and demolition waste; a general decline in road building expenditure over the period; the lower intensity and improved use of aggregates in construction due to technical improvements such as the use of thinner high performance asphalt layers in road construction.

6 Conclusions

This study has mainly explored the application of taxes on sand, gravel and rock by reviewing the experiences from four EU Member States. The use of charges in the four countries have also been analysed to explore their potential incentive to strengthen sustainable resource management. The contrasting nature of the contextual factors (political, economic, social, geological and technical) coupled to different objectives and effects, has provided a rich source of material to highlight differences in tax policy design and draw important findings and lessons, which include the following:

1. **The national objective(s) for introducing taxes on sand, gravel and rock varied** across the countries included in the study reflecting different economic and environmental priorities. In the Czech Republic the objective of the tax or charge is to raise revenue (both to state and municipality budgets) and to encourage deep mining and preserve the landscape. For Italy the goal is to compensate for the environmental costs caused by quarry activity and to protect the landscape. Sweden has introduced taxes or charges to safeguard gravel resources and water quality and to preserve the landscape. The UK aggregates levy is to compensate for environmental externalities caused by quarry activity (noise, dust, pollution, habitat loss, etc.) and to reduce demand for aggregates and encourage recycling.

2. **The market structure for extraction and recycling activities varies considerably.** Italy has by far the greatest number of companies and sites operating in the aggregated sector, suggesting that the industry is competitive. In contrast, the United Kingdom and Sweden have much fewer companies operating, and a small number of firms have a significant market share, For example in Sweden, the market is dominated by a few very large operators with around 10 % of the firms producing almost 70 % of the total of aggregates. The United Kingdom has the highest recycling rate of aggregate materials, which accounts for almost 25 % of the UK aggregates market — the largest recycled market share of any European country. Italy and the Czech Republic have very low recycling rates, which is due, in part, to a strong consumer preference for virgin aggregate materials and the lack of any significant price difference between virgin and recycled materials within these countries.

3. **A number of wider policy factors influence extraction practices**. It was recognised that a combination of policies was needed to stimulate a change in production methods and practices. The aggregate tax has often formed an important component of the policy package and it is this integrated approach that creates incentives to which the industry can respond. The tax therefore need to be used as part of a package of policy interventions based on a systemic analysis of the factors which influence the impacts from the extraction of sand, gravel and rock resources. The combination of taxes with other policy levers introduced as a package of policy measures is likely to be more effective in delivering environmental improvements.

4. **The applied taxes reflect different national priorities**. The Czech Republic and Italy both introduced low tax rates that have remained relatively unchanged. In contrast the United Kingdom and Sweden introduced higher taxes that have gradually been increased to provide a stronger price signal to the industry. The different rates of tax as a percentage of the average price for sand, rock and gravel differ in the various countries from 3 % in the Czech Republic, 5 % in Italy, 12 % in Sweden to 20 % in the United Kingdom.

5. **The effects of the tax in relation to the national objective provided mixed results**. There was not any clear evidence in Italy or the United Kingdom to show that the objective of reducing environmental externalities had been achieved. In the Czech Republic and

Italy there was only very weak evidence to show that the landscape had been improved following the introduction of the tax. Sweden was the only country which had positive results to show an improvement in landscape with respect to natural gravel by reducing demand for these materials. However, it was reported by Ministry and industry interviewees that this had been achieved through a combination of measures rather than attributing the full effect to the gravel tax. In the United Kingdom there was insufficient data to say for certain whether the aggregate tax had influenced demand significantly, although analysis undertaken by the Ministry for Revenue and Customs had provided some initial positive results.

6. **There are difficulties in reflecting environmental damages in the size of the tax**. None of the countries included in the study vary the tax or charge across different locations to reflect the extent of environmental damage, although the Czech Republic is considering introducing this approach. The Czech Republic is revising the basis for its mining charge to reflect the ecological impact. However, calculating the ecological score is complex, and concerns have been raised about whether the administrative costs will exceed the benefits. It is interesting to note that none of the other countries, included in the study, have attempted to vary the tax or charge across different locations to reflect the extent of environmental damage. The United Kingdom was the only country that set the tax rate on the basis of a contingent valuation study that estimated the total external costs of aggregates extraction in the region of EUR 558 (or GBP 380 million) per year.

7. **Tax or charge distortions across country borders need to be considered** when deciding the appropriate rate of the tax. Co-ordination is relevant where countries have natural land borders and differences in tax rates can lead to perverse trade flows. This can lead to an overload of extraction in the lower or no tax regions. The United Kingdom country study highlighted an unintended trade distorting effect due to the proximity of Northern Ireland (with aggregate levy) to Ireland (without levy).

8. **Wider environmental impacts and trade offs need to be considered at an early stage in the design of the tax**. In Sweden the benefits of preserving natural gravel for groundwater reservoir (i.e. aquifer) material were deemed to be greater than the costs from greater energy use in extraction. The tax encouraged the substitution of crushed rock for natural gravel, which required approximately three times more energy per tonne to extract. Unfortunately no measures were available to compare the costs and benefits of these impacts.

9. **Use of revenue raised from the tax needs further analysis**. Earmarking of the revenue can help to reinforce the impact of the tax, since it needs to address specific market failures and improve environmental outcomes. For example, the United Kingdom used a proportion of the tax revenue to develop quality standards for recycled aggregates, which gave companies confidence in purchasing and using these materials. This was reinforced through awareness-raising campaigns to encourage local authorities to purchase recycled materials when carrying out local infrastructure projects.

10. **Indirect effects of the tax from improvements in the quality of information** arising from monitoring of the extraction activity. This indirect effect was registered in both Sweden and Italy where, previously, the monitoring was either approximate or non-existent. The requirement for the authorities, in order to calculate the tax ,to know exactly how much aggregates is extracted per year made it necessary to develop better systems for monitoring the activities at a quarry level. The tax has, therefore, helped improve the quality and reliability of extraction data, which can then be used as a basis for encouraging changes in quarry management activities.

11. **There is potential to expand the use of taxes in the area of natural resource management**. Taxes on energy resources are the most widespread form of MBIs in Europe. In 2005 energy taxes were by far the most significant, representing around three quarters of environmental tax receipts. Pollution taxes and resource taxes, raise only a marginal amount of revenue in that together they make up just 4.1 % of total environmental taxation (Eurostat, 2007b). A tax on aggregates, if properly designed and combined with other instruments, could have positive effects on the environmental impacts of aggregates and construction.

12. **The competitiveness of the aggregate sector did not change as a result of introducing taxes**. In part this was due to the nature of the product, with the transport of bulky aggregate

materials constituting a significant proportion of the cost. This makes it uneconomic to transport over long distances and production is constrained by local demand factors. By reason of the limited volume of trade in this area, international competitiveness is not a major concern of the aggregates industry.

13. **Design additional monitoring systems to assess the change in impact on the environment**. When applying taxes and charges on aggregates it is important not only to focus on the economic effectiveness but also the environmental effectiveness. An additional monitoring system would help assessing whether the size of a tax or a charge have positive or negative impacts on the environment and hence reveal the environmental effectiveness of these levers.

14. **Taxes can help to promote innovation and support research and development**. For example, the United Kingdom used a proportion of the tax revenue raised from the MBI to subsidise capital investment in recycling operations. This facilitated the entry of new firms into the market. These new entrants encouraged higher levels of innovation by challenging existing working practices and improving the quality of recycled materials.

Annex: methodology

Overview

The methodological approach has been to analyse data, review existing reports and to work with recognised experts in the selected countries in order to understand the objectives of the MBI and relationships with other policy instruments. This has involved undertaking a systemic analysis of the main factors influencing the use of sand, gravel and rock resources to assess whether the MBI achieved the intended environmental objective(s).

The process has been iterative to ensure that the results are supported by data and also the opinions of key stakeholders. From this, informed conclusions were drawn on the intended and unintended effects of the MBI. These were subsequently reviewed by country experts, both government and industry, to ensure they are robust and legitimate.

The methodology is split into two main areas. The first relates to the technical analysis, which includes quantitative and qualitative analysis using existing data and information provided by industry and government sources. The second covers the process design, i.e. identifying who should be involved when, where and how. Process design is essential if the full learning benefits are to be gained from the technical analysis.

Technical analysis

The analysis of causality in each of the studies can be broken down as follows.

1. Analysis of the sand, gravel, rock charge or tax, their objectives and relationships with the package of relevant Government interventions, i.e. what was the intervention and how was it intended to work.

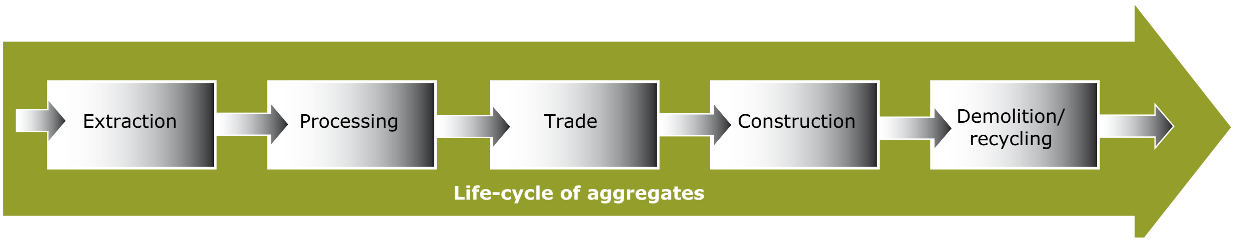
2. PEST analysis i.e. political, economic, social and technological. Considering the dynamic effects that drive the behaviour of the targets of the interventions i.e. what does the system look like prior to the policy intervention — the 'baseline assessment'.

3. Analysis of the relationship between the baseline assessment and the policy intervention i.e. how might the intervention have actually affected the system, at what cost and when — the impact hypothesis(-es).

Each of the country studies used a life-cycle assessment framework to examine the factors influencing impacts on the markets for sand, gravel and rock. The approach is illustrated in the diagram below and examines the flows of sand, gravel and rock resources as they are extracted, processed, used and then eventually disposed of or recycled at a later stage.

This system mapping facilitated a consistent approach but also allowed each of the country studies to explore in greater depth notable differences in the structure of the markets and policy levers that were exerting an influence at various stages in the life cycle.

Figure 6.1 Life-cycle of sand, gravel and rock



Source: Wuppertal Institute (own compilation).

The approach helped to underpin the PEST analysis by ensuring the various factors influencing the aggregate sector were considered across the whole of the life-cycle system. The PEST analysis examined the political, economic, social and technological factors influencing the use of aggregate materials. This considered the dynamic effects impacting on the system prior to the introduction of the tax, which provided a 'baseline assessment' of key factors impacting on the use of sand, gravel and rock materials.

Within each of the broad categories of the PEST a number of sub-factors were assessed in relation to whether they exerted a strong, moderate or weak influence on the use of aggregate materials in the country being studied. The level of influence for each factor provides an indication of the relative strength or weakness compared to the other countries included in the study at a national level. The ratings were not intended to provide a precise score, but instead reflect a judgement based on the quantitative and qualitative evidence collected during the study. It is expected that due to the nature of aggregate markets, which typically serve local communities, the results would vary at a regional and local level

Once the PEST analysis had been completed each of the studies assessed the causal relationship between the tax instrument and selected indicators. These were chosen to provide evidence of whether the original objectives of the tax had been met and are described in Figure 6.2.

The first stage of analysis examined whether the tax had influenced sales of gravel, sand and rock. In some cases the sales of substitutes, such as recycled or untaxed materials, were also included where they were being influenced by the introduction of the tax or charge. These indicators provided a view as to whether the tax was having an effect on the quantity of material being extracted at the quarry sites and transported, i.e. whether any economic change had taken place.

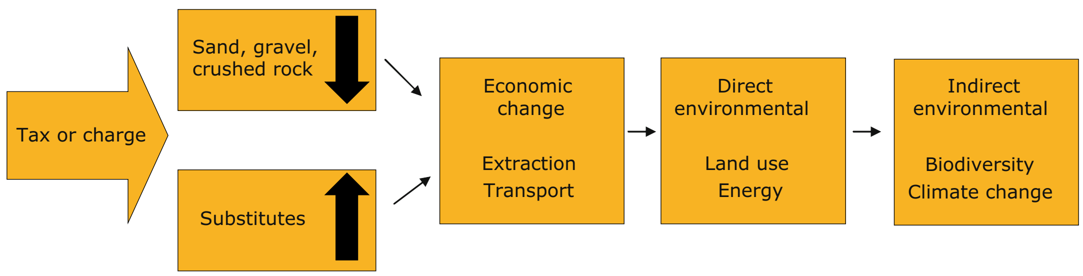
The next stage of analysis explored whether the change in extraction or transport activity had resulted in any direct environmental improvement, through land or energy use. It also examined whether environmental externalities associated with extraction had improved. The final consideration was whether any indirect environmental benefits had occurred in relation to biodiversity or climate change, although it was recognised that this was difficult to measure.

The change of these indicators was investigated systematically through data analysis (e.g. econometric studies were undertaken in Italy) and interviews with local experts to establish whether any effect had been recorded following the introduction of the tax. This process ensured that the original objectives for introducing the tax were tested and supported by data and also the opinions of key stakeholders. It led to a small number of hypotheses, which were reasonably supported by the data and key stakeholders' views. These examined both the intended and unintended effects of the MBI and considered the interaction with wider policy measures, identified within the PEST analysis. From this conclusions were drawn as to what actually happened as a result of introducing the sand, gravel, rock tax and why.

Process design

The process design relates to identifying which stakeholders should be involved. A stakeholder analysis was initially conducted for each of the studies to distinguish between two distinct groups:

Figure 6.2 Causality framework



Source: Environment Agency England and Wales (own compilation).

1. those individuals who have knowledge and understanding of the key processes;

2. those individuals who have a political interest in the sand, gravel and rock tax.

The main considerations included assessing the stakeholder interest, influence and knowledge of the policy process. Once the relevant stakeholders had been identified an engagement strategy was developed, which had three main objectives:

1. ensuring that the right information is collected, by quality assurance of the data and validating the analysis with stakeholders;

2. learning is interactive, by explaining the results of the analysis to stakeholders and recording their ideas and opinions;

3. conclusions have legitimacy, by undertaking accurate analysis and actively involving political stakeholders throughout the process.

A range of approaches were used to support these objectives which included using questionnaires and undertaking interviews. It was very much an iterative process to ensure that the results were supported by data and also by the opinions of key stakeholders. From this, informed conclusions were drawn on the intended and unintended effects of the MBI. These were subsequently reviewed by country experts, both government and industry, to ensure they are robust and legitimate

A stakeholder and expert workshop was held in February 2007 in Copenhagen which provided an opportunity for national experts from each of the countries to review the findings and provide comments. A further industry and country stakeholder consultation exercise was then conducted during September and October 2007 which provided further opportunity for comments on the report, before the final version was completed.

Glossary of abbreviations

ALSF	Aggregate Levy Sustainability Fund
CEO	Chief Executive Officer
CSU	Czech Statistical Office
CZK	Czech crowns
DCLG	Department for Communities and Local Government (UK)
DG	Directorate-General
DKK	Danish crowns
DMC	Domestic material consumption
DMI	Direct material input
EAP	Environmental Action Programme
EC	European Commission
EEA	European Environment Agency
EPA	Environmental Protection Agency
ETC RWM	European Topic Centre for Resources and Waste Management
EU	European Union
EUR	Euro
GDP	Gross domestic product
HMRC	Her Majesties Revenue and Customs Department (UK)
MBI	Market-based instruments
MJ	Megajoule
NAMEA	National accounting matrix including environmental accounts
OECD	Organisation for Economic Co-operation and Development
ODPM	Office of Deputy Prime Minister (UK)
PEST analysis	Political, Economic, Social and Technological analysis
QPA	Quarry Products Association
SEK	Swedish crowns
SGU	Swedish Geological Survey
TGV	High-speed train
Tkm	Tonne-km
UEPG	European Aggregates Association
WI	Wuppertal Institute for Climate, Environment, Energy
WRAP	Waste & Resources Action Programme
UK	United Kingdom of England, Wales, Scotland and Northern Ireland

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European Environment Agency

Effectiveness of environmental taxes and charges for managing sand, gravel and rock extraction in selected EU countries

2008 — 59 pp. — 21 x 29.7 cm

ISBN 978-92-9167-267-7
DOI 10.2800/35981

TH-AL-08-002-EN-C
DOI 10.2800/35981

Price (excluding VAT): EUR 15.00

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ISBN 978-92-9167-267-7

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