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Report on the monetary valuation of the urban, peri-urban and rural service supply

Part A: Monetary Valuation Techniques

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SIXTH FRAMEWORK PROGRAMME

Contents

Abstract

Objectives / aims

This report aims to provide the basic concept of economic value and to give a brief overview of monetary valuation techniques commonly used to identify this value.

Methodology

A literature review is carried out for urban, peri-urban and rural supply services, which focuses on valuation studies. The information is organized according to a general conceptual framework consistent to the European Environmental Agency (EEA) ecosystem and land cover accounts, available empirical evidence, built for the purpose of cost-benefit analysis of land-use strategies.

Findings

In general it can be concluded that values found in the literature usually vary by space, time, and
research methodology applied. Due care must be taken when comparing values from different studies. Double counting issues may arise when adding or subtracting costs and benefits from different studies.

Classification of results/outputs:
For the purpose of integrating the results of this deliverable into the PLUREL Explorer dissemination platform as fact sheets and associated documentation please classify the results in relation to spatial scale; DPSIR framework; land use issues; output indicators and knowledge type.

Spatial scale for results: Regional, national, European	Regional/European
DPSIR framework: Driver, Pressure, State, Impact, Response	Driver/Pressure/State/Impact/Response
Land use issues covered: Housing, Traffic, Agriculture, Natural area, Water, Tourism/recreation	housing, tourism, traffic, water, natural area
Scenario sensitivity: Are the products/outputs sensitive to Module 1 scenarios?	No
Output indicators: Socio-economic & environmental external constraints; Land Use structure; RUR Metabolism; ECO-system integrity; Ecosystem Services; Socio-economic assessment Criteria; Decisions	Socio-economic assessment criteria
Knowledge type: Narrative storylines; Response functions; GIS-based maps; Tables or charts; Handbooks	Review, tables

How many fact sheets will be derived from this deliverable:	**0**

1. Introduction

The EEA land cover accounts consist of 44 categories classified under 5 main land cover categories: Artificial Surfaces, Agricultural Areas, Forest and Semi-natural Areas, Wetlands and Water Bodies. In our general conceptual framework we aggregate some of the EEA land cover classes to match the empirical evidence offered by socio-economic valuation studies. The result is shown in table 1.

Each land cover type has a certain functionality or capacity to provide goods and services for the direct or indirect satisfaction of human needs (De Groot, 1994). Following De Groot (2002) we distinguish four main functional categories: regulation, production, habitat and information. Each functional category allows the supply of a certain set of goods and/or services (see table 2). The actual supply of these goods and services ultimately depends on how land is used and the endowment of capital and labour available to society. The value of these goods and services depends on society's spending for such goods and services.

We consider three types of capital resources: natural capital, manufactured capital and financial capital. By natural capital we mean natural resources with particularly slow regenerating processes such as forests, wetlands, water bodies, biodiversity and mineral deposits. Manufactured capital includes instead infrastructure such as gas and water pipes, power lines, transport and telecommunication networks and facilities such as schools, hospitals, police stations and so on (see table 4 for a complete list of the categories considered). Financial capital is represented by income available to households, savings available to firms and tax returns available to the government. Labour can be divided instead in three categories: high, medium and low skilled labour.

Land use change impacts the supply of goods and service by changing the functionality of the unit of land in question and the stock of capital and labour available to society. To evaluate changes in land use, therefore, land cover accounts need to be supplemented with socio-economic accounts associating a value to changes in land use.

2. The urban, peri-urban, and rural good and service supply

Complementing land cover accounts with socio-economic accounts requires the identification of urban, peri-urban and rural good and service supply. Given that our analysis focuses on European countries, our identification is based on classes of goods and services as used in the Eurostat databases. We refer, in particular, to the three classifications used for national accounts: NACE (industry revenues), COICOP (Household expenditure) and COFOG (Government expenditure). Referring to these three classifications will allow us later on to link the data collected in this report to the output of macro models such as NEMESIS.
Each good and service category, furthermore, is associated to a specific functional category.

The outcome of our identification and classification process is shown in table 5. For the habitat function we identify:

- Health and environment protection including waste management
- Housing and amenities
- Security and safety
- Social Coesion

For the information function we have

- Education
- Recreation, Culture and Religion

For the production function we have

- Goods

For the regulation function we have

- Electricity, Gas, Water and Fuel supply
- Commerce
- Post and Telecommunications
- Transport
- Other services (e.g. financial intermediation, general public services)

This classification includes all goods and services taken into consideration in the gross domestic product (GDP) accounting and includes the sector classes used in the SENSOR project: agriculture, forestry, tourism, nature conservation and transport and energy infrastructure. Agriculture and forestry are considered in the category “goods”, tourism in the category “recreation, culture and religion”, nature conservation in the category “health and environment protection including waste management”, transport and energy infrastructure in the categories “Transport” and “Electricity, Gas, Water and Fuel supply”. The exact classification according to Eurostat NACE, COICOP and COFOG classification is shown in table 5.

3. Monetary valuation of urban, peri-urban and rural good and service supply

Researchers place monetary values on goods and services according to the concept of full economic value of those goods and services. The full economic value includes use and non use values. Use values include direct use, indirect use and option values. Non use values include existence values, bequest values and option values.

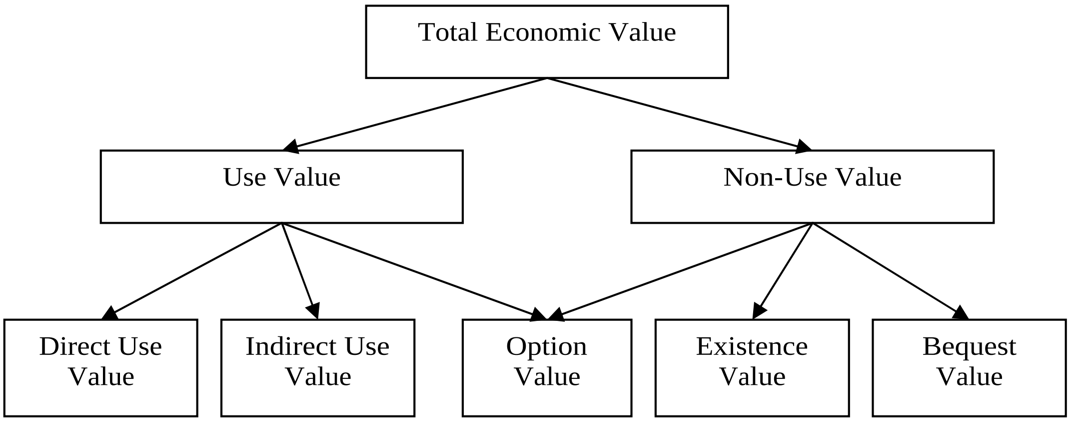
Direct use values are values attached to the direct consumption of the good or service in question, while indirect use values are services associated to but not directly deriving from direct consumption that have a use value for society. As example we can think of some special functions of ecosystems like waste assimilation or provision of habitat for wildlife.

The option value represents the value society attaches to the potential for the good or service to be available in the future. The value of preserving biodiversity is an example of option value. This value can be regarded as a use value or as a non-use value depending on the nature of the option.

Existence and Bequest values represent the value of knowing that a good or service exists and the value we attach to the possibility that it will be available to future generations respectively.

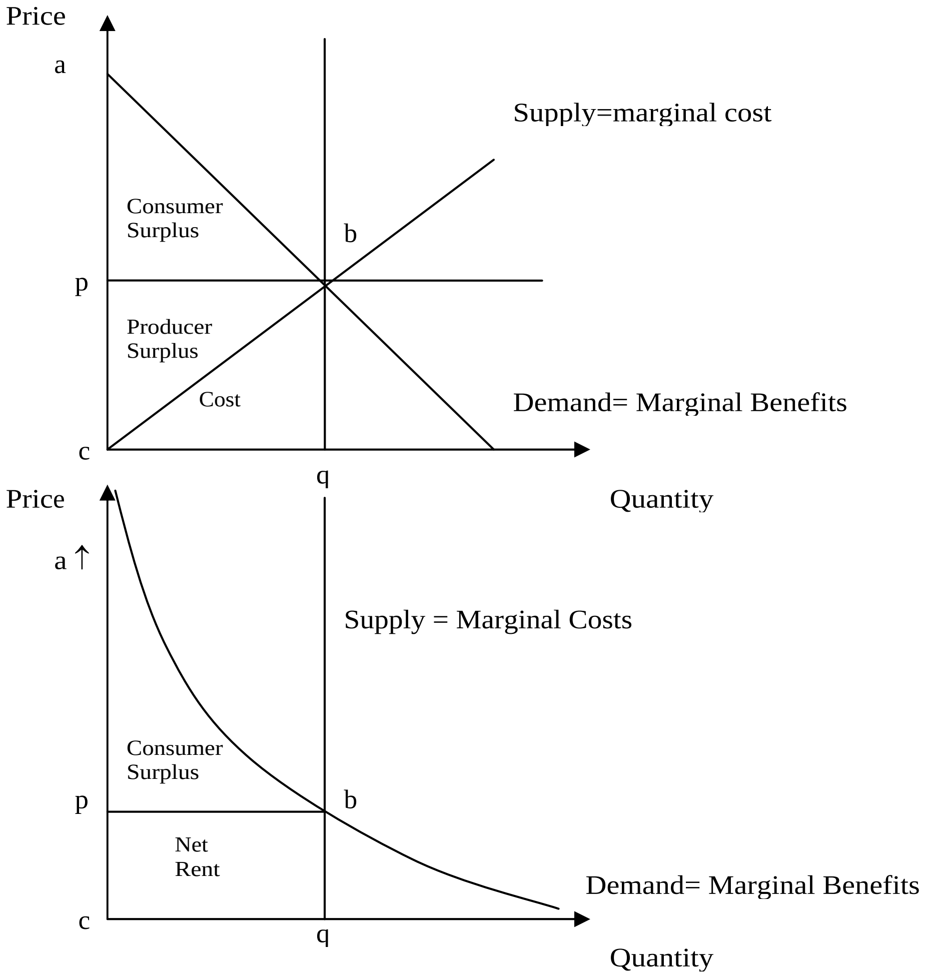
The total economic value can be represented schematically as shown in figure 1:

Figure 1: Sources of value



Economic values are not only classified based on the type of use, non-use that market agents are going to make of the good or service, but also depending on the type of market agent taken into consideration. Based on neoclassical economic theory we have two main types of economic agent whose change in welfare should always be considered when valuing good or services: consumers and producers. The total economic value of a good or service is then defined as the sum of consumer and producer surplus. The concept of surplus is shown graphically in figure 2 where the area apb represents consumer surplus, the area cpb represent producer surplus or net rent and the area cqb (which is zero in second graph) represent production costs. The area pbqc represents revenues or gross rent. The first graph in figure 2 shows a traditional human made substitutable good, while the second graph represent a possible figurative market for an environmental service. Gross Domestic Product (GDP) takes into account area pbqc and only for those goods and services that are traded in a market. The total economic value is instead the sum of areas abp and area pbc. As such, the total economic value of a good or service is only partially represented by GDP measures.

Figure 2. The Concepts of Consumer and Producer Surplus



Source: Costanza et al. (1997)

Valuation techniques employed to identify the total economic value of goods and services are divided into two categories: market valuation techniques and non-market valuation techniques.

Market valuation techniques identify the value of goods and services based on consumer preferences revealed in market transaction occurred in the explicit market place for such good or service. The replacement cost method and the change of revenue method are an example of such technique. If an explicit market does not exist, the valuation technique refers to the market of a closely related good or service from which the value of the targeted good or service can be implicitly derived. Travel cost and hedonic valuation methods belong are an example of such valuation methods. Another possibility is to create a laboratory experiment simulating proper market conditions. Experimental auctions with true exchange of money and good are an example of such valuation technique.

Non-market valuation techniques derive the value of goods and services with stated preference techniques. Contingent valuation and conjoint analysis belong to this category. Non-market valuation techniques are usually employed to identify non-use values. The validity and reliability of such value estimates is often challenged in the literature due to the potential for hypothesis bias. Meta analytic studies conducted to investigate this issue are often able to find sources of variability among value estimates and are able to make this variability predictable for benefit transfer purposes (Santos, 1998).

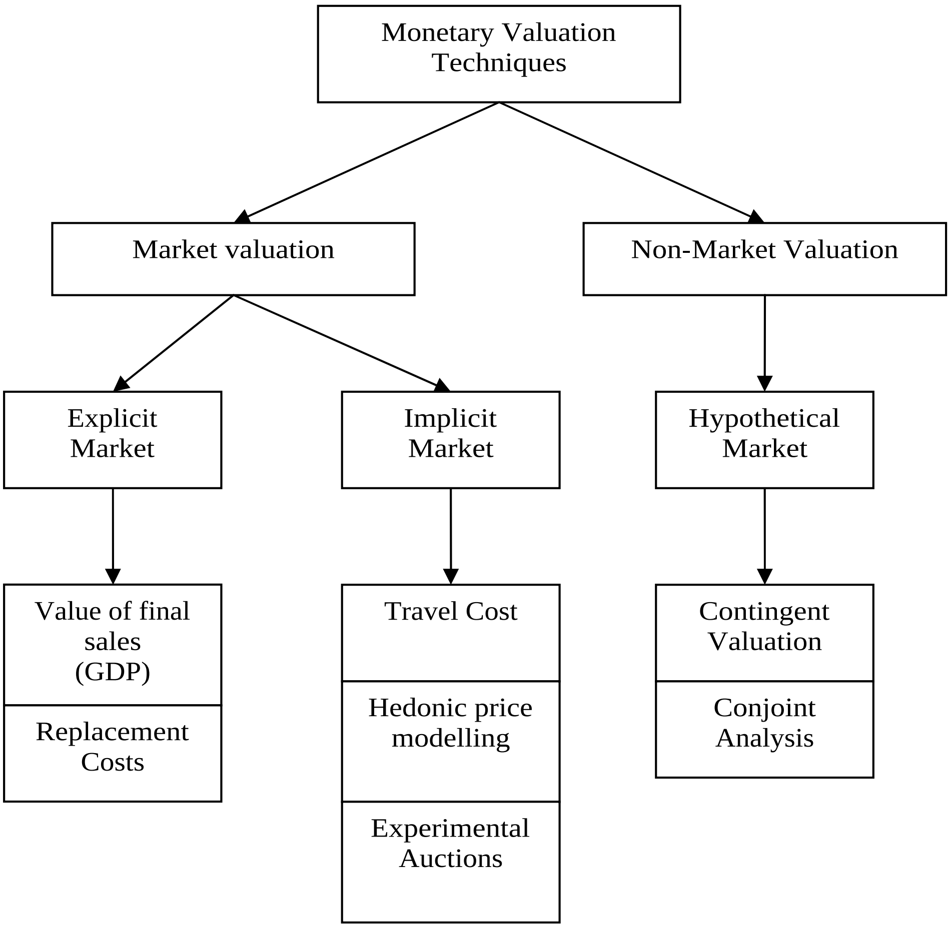
To the extent to which the valuation study targets a specific product attribute, or function or the bundle of attributes and functions of the good or service being analyzed, the outcome of the valuation study will deliver a part or the total economic value of the good or service in question.

Due to double counting issues, the total economic value of goods and services cannot be found by simply adding the outcome of valuation studies identifying parts of the value of the good or service in question. As the socio-economic value or total economic value of a good or service is the sum of the socio-economic value of this good or service to producers and consumers, only values identified in studies focusing on producer values only (e.g. value of sales or added value) and in studies focusing only on consumer values (e.g. implicit market and non-market valuation studies) can be added. Thus values of the same good or service obtained from different implicit market or non-market valuation studies should not be added to find the total economic value. The total economic value will then be the set of values composed by the outcomes of such studies.

To identify the monetary value of the urban, peri-urban and rural service supply we considered the following sources of information: official statistics, existing EU project such as SENSOR and ExternE, meta-analytic studies and other valuation studies.

Figure 3 shows a schematic representation of monetary valuation techniques

Figure 3 – Example of Monetary Valuation Techniques



The valuation methods listed under explicit market techniques focus on measures of producer surplus, while those under implicit market and hypothetical market focus on measures of consumer surplus. Adding results within the implicit market category and the hypothetical market category may not be appropriate due to double counting issues. Even adding measures of consumer surplus from different sites may not be appropriate as it is often found in the literature that these measures are not linearly additive in geographical scope for example due to substitutability among sites (see for example Santos, 1998).

This section continues with a literature review of monetary values attached to urban, peri-urban and rural service categories selected from those identified in section 2. Figures in tables are reported according to the currency and time reported in the study (for transparency). In the text the most important figures are shown in parenthesis in 2007 €. The consumer price index is used as a deflator where necessary.

3.1 Health and Environment Protection

3.1.1 Health

Human health impacts frequently considered in the rural urban contests are those associated to air pollutants, contamination of drinking water, increased risk of floods, traffic accidents, health impacts due to choice of transport mode, and impacts on psychological well-being due to landscape change.

Air Pollutants

According to various studies, the foremost transport-related air pollutants are: particulate matter, nitrogen dioxide, carbon monoxide, benzene and ozone.[1] Other forms of air pollution (e.g. sulphur dioxide) typically produced at stationary sources such as factories and power plants are not particularly relevant to this study (only transport emissions are considered as they are directly related to urban development patterns). Asthma is one of the most widely felt impacts of vehicle emissions and reduced air quality. Ozone is particularly hazardous as it attacks the body's airways, making it sensitive to inflammatory allergic reactions from PM and pollen (Friends of the Earth, 1997). For example, EPA (2003) finds that during the 1996 Atlantic Olympic Games, emergency room visits for asthma dropped by 41.6% as a consequence of reduced driving and an associated 27.9% fall in ambient ozone levels. In the UK, Buchdahl, et al, (1996) finds that higher concentrations of ozone are strongly linked to an increased attendance at accident and emergency departments for acute childhood wheezy episodes (the results being independent of temperature and season).[2]

Contaminated Drinking Water

Various health risks due to water contamination exist (Table 6). The list is not exhaustive nor does it imply that all of the above pollutants can be found in water run-off at every location. Nevertheless, they represent some of the more commonly found water pollutants mentioned by earlier studies (e.g. nitrogen, phosphorus, heavy metals etc). The excess concentration of these chemicals typically originates from sources such as lawn fertiliser, household waste, construction by-products, industrial waste and vehicle emissions/fuels. The key point being that urban development is directly related to vehicle usage and water run-off levels.

Floods

For the most part the health impacts of increased flood risks are the same as that of drinking water contamination. However, there are several factors which are specifically related to flooding, notably drowning and certain water-borne diseases.[3]

Transport

Another issue to be concerned with is the health impact of travel modes. As argued previously, compact development with centrally located infrastructure (such as schools) encourages walking and cycling. Doing so not only reduces pollutants but also increases

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[1] Ozone is indirectly produced from vehicle emissions when NO_x chemically reacts with naturally occuring VOCs (with energy from the sun).

[2] Rossi, et al, (1993) finds that temperature and NO_2 levels increases the likelihood of asthma attacks.

[3] Research papers by the Centers for Disease Control Prevention (CDC) outline some of these health impacts, though they tend to be more applicable to less developed countries.

physical exercise. For example, Cooper, et al, (2006) found Danish children who cycled to school were five times more likely to be in the top 25% of healthy children, whilst Frank and Engelke (2001) specifically argue that there is a relationship between the built environment and physical exercise, claiming that: "*...regular physical activity can reduce risk factors for many chronic diseases including coronary heart disease, some cancers, hypertension, diabetes, osteoporosis, obesity, anxiety and clinical depression.*" It is also likely that a substitution away from vehicle use to cycling/walking might reduce the total number of Road Traffic Accidents (RTA). Saelensminde (2002) highlights this issue when considering the health impacts of walk and cycle networks in Norway. However, the study does not go on to include them in the final model for lack of a well defined method of going about this issue. Either way, it is suggested that the impact urban development has on travel modes and associated number of RTA should be strongly considered in any further comprehensive studies.

Landscape

The impact of urban development on landscape amenity has been discussed in earlier sections, although the link between landscape amenity and health is yet to be made clear. However, only a couple of studies specifically look at this relationship and so little statistical evidence is available to prove (or disprove) the hypothesis that natural landscape enhances psychological well-being and health. Another critique is that aggregate benefits (and therefore WTP) are likely to be low because the population of relevance is very small (Willis, et al, 2000).

Despite these criticisms, Ulrich (1986) argues that natural views are preferred over urban landscapes and that "*...the benefits of visual encounters with vegetation may be greatest for individuals experiencing stress or anxiety.*" In a subsequent study, Ulrich et al, (1991) find that certain physiological measures (including heart period, muscle tension, skin conductance and pulse transit time) have faster recovery times when subjects were exposed to natural as opposed to urban environments. Saying this, the natural environment consisted of trees, open spaces and a stream whereas the urban scenario comprised of traffic, pedestrians and noise pollution. Hence, landscape is only one factor contributing to this effect. Moreover, as Willis, et al, (2000) point out, the existing research does not relate the size of woodlands to health impacts. This is a damaging critique on the health benefits of woodlands as a handful of trees planted at a relatively low cost could be just as beneficial as an entire a forest (Willis, et al, 2000).

Monetary valuation of Health Impacts

Changes in the Human Health status can be evaluated in terms of mortality, acute and chronic, and morbidity.

Welfare losses due to mortality are usually identified by means of stated preference studies where respondents are asked to value a reduction in the risk of death. Once the willingness to pay (WTP) of respondents for a reduction in the risk of dying r is obtained, the value of a statistical life is found dividing WTP by the risk reduction r. So for example, if the WTP for a 1 in 10000 reduction in the risk of death is €30, the VSL=€30/ (1/10000) = €300000. Sometimes it is useful to convert this value in the value of a statistical life year by using remaining life expectancy (see details below). Because VSL based on mean WTP is more sensitive to outliers than VSL values based on median WTP, we will in general report only the latter values when available.

Welfare losses due to morbidity are of three basic types:

- resource costs,
- opportunity costs, and
- disutility.

Resource costs (RC) include medical costs, and any other out-of pocket expense paid by state, insurance or individuals. Opportunity costs (OC) include productivity losses due to losses in work time, and leisure losses (including non-paid work) due to losses in leisure time. Disutility (DC) includes other socio-economic costs such as pain and suffering, reduced enjoyment of leisure activities, anxiety about the future, and concern and inconvenience to family members and others. Illness can be evaluated summing these costs such that:

Value of Illness = RC+OC+DC

Resource costs can be recovered through market transaction and, therefore, through industry, consumer and government spendings. The overall consumer and government health expenditure is shown in table 7. Monetary values that can help us value changes in health status as found in the literature are shown in table 8 and explained below.

Mortality (chronic and acute)

The value of statistical life (VPF or value of prevented fatality) suggested by the ExternE project is $€_{02}$ 1.052 million ($€_{07}$ 1169) (standard error 128.4) for a 5 in 1000 immediate reduction in the risk of death. This value can be converted in Value of Statistical Life Year (VOLY) by using remaining life expectancy as calculated in Rabl (2002): “Rabl’s calculations are based on an exponential hazard function, h(t)=a * exp(bt), where t is current age, and a and b are equal to 5.09 * E-5 and 0.093 for European Union males, respectively, and 1.72E-5 and 0.101, respectively, for European Union females.” (ExternE, 2003, p.147). Then VOLY= 12*(VPF/h(t)). The VOLY for chronic illness induced mortality used in the extrernE project based on own surveys conducted in France, England and Italy is $€_{02}$ 55,800 (median) ($€_{07}$ 62014) (range: €24,240 –€ 250,000). The VOLY for acute illness induced mortality is about $€_{02}$ 75,000 ($€_{07}$ 83352) (median with a discount rate of 3%). These values represent the value of a statistical life-year. Following Aragoni Ortiz these values can be converted to values for a different year using the price index EU HICP (Eurostat) for the EU-25.

Alberini (2005) in a contingent valuation study carried out in Italy identifies the value of a statistical life for two risk reductions: 1 in 1000 over 10 years (1:10000 a year) and 5 in 1000 over 10 years (5:10000 year). The author finds “support for the EU-wide figures recommended in the cost-benefit analysis of the Clean Air for Europe program, which are €0.980 ($€_{07}$ 1.136) million and €2.0 ($€_{07}$ 2.319) million, respectively (2000 euro). Our VSL figures bracket those used by the European Commission, whose baseline central VSL is €1.4 million, but are below that used by the US Environmental Protection Agency ($6.1 million, 1999 dollars), which is dominated by labor-market VSL values" (p.30).

Alberini also finds that VSL varies with risk but not proportionally, age, health status (cardiovascular problems) and income. Marital status, number of children and education do not have a significant impact on VSL. The VSL of a healthy 30-49-year old is $€_{03}$2.282 ($€_{07}$ 2487) million when referred to a 1 in 1000 risk reduction over 10 years, and $€_{03}$0.831 ($€_{07}$ 0.906) million when referred to a 5 in 1000 risk reduction (based on median WTP). For the healthy 60-69 year-old, the VSL is $€_{03}$1.160 ($€_{07}$ 1.264) million for a 1 in 1000 risk reduction and $€_{03}$0.422 ($€_{07}$ 0.460) million for a 5 in 1000 risk reduction. For a 60-69year-old with cardiovascular or respiratory health problems the VSL is $€_{03}$1.625 ($€_{07}$ 1.771) for a 1 in 1000 risk reduction and $€_{03}$0.532 ($€_{07}$ 0.580) million for a 5 in 1000 risk reduction. These figures are based on median values for a household member in Italy, male, married, no children, no college degree.

Hospitalization costs

Monetary values presented in table 8 come from a contingent valuation study carried out by Ready *et al*. (2004). In this study the mean value of hospital admissions for respiratory illnesses imply the patient staying in the hospital for three days, followed by five days at home in bed. The value found for hospital admissions is $€_{03}$ 468 ($€_{07}$ 510) per occurrence. To this value the productivity loss for 8 days of $€_{03}$ 704 ($€_{07}$ 767) ($€_{03}$ 88 ($€_{07}$ 96) per day) and costs of hospitalisation for three days at $€_{03}$ 969 ($€_{03}$ 323 ($€_{07}$ 352) per day) is added. This gives a total economic estimate of $€_{03}$2,141 ($€_{07}$ 2,334) per Hospital Admission from respiratory distress.

The costs of hospitalization are the average costs of a wide variety of specialist treatments, for use when precise information about the nature of the individual's hospital contact is not known. These costs derive from generic unit costs (expressed at factor costs) for hospital-based health care from a study by Netten and Curtis (2000), and MEDTAP International, reported in Ready *et al*. (2004). Data is available only for 7 European countries and mean values are used as a proxy for the EU. Because UK appears as an outlier it is recommended to use mean values without the UK ($€_{03}$ 23 ($€_{07}$ 25)) as lower bound. For cardiology, the inpatient unit cost is 1.92 higher than the generic unit cost. This multiplier is then applied when heart-related conditions are considered.

Productivity loss

The costs of absenteeism adopted are based on figures contained in Confederation of British Industry (CBI, 1998). The direct costs of absence are based on the salary costs of absent individuals, replacement costs (i.e. the employment of temporary staff or additional overtime) and lost service or production time. The median direct cost to business per employee-day absence is $€_{03}$ 85/day ($€_{07}$ 93/day) (mean is $€_{03}$ 114/day ($€_{07}$ 124/day)). It is assumed that absenteeism does not have an impact on the wage rate. The indirect cost/day is estimated at $€_{03}$ 168 ($€_{07}$ 183)), but the authors have low confidence in this estimate so that only direct costs are used to compute the central value for the analysis.

Alternatively information from EUROSTAT can be used to derive mean annual gross earnings paid to EU employees and divide this by data on the size of the labour force to give a value of marginal productivity – assuming wages equal marginal productivity. This gives a value of $€_{03}$ 56 ($€_{07}$ 61). This estimate does not include all costs (direct or indirect) associated with absenteeism but can be used as a lower-bound estimate.

In order to derive country-specific estimates of the direct and indirect costs presented for the UK by the CBI, ExternE suggests scaling the EUROSTAT country data relative to the EUROSTAT data for the UK and applying these scaling factors to the values derived from the CBI study. Where the data are not available, data on the country purchasing power parity relative to the UK were used to derive appropriate scaling factors. Mean values across the EU are €$_{03}$ 58 (€$_{07}$ 63), €$_{03}$ 88 (€$_{07}$ 96) and €$_{03}$ 261 (€$_{07}$ 285) for low, central and high values respectively. In aggregating the costs below, we use the central value of €$_{03}$ 88 (€$_{07}$ 96).

Emergency-room visits for respiratory illness

Based on Ready *et al*. (2004) estimated WTP to avoid a visit to a hospital casualty department, required for oxygen and medicines to assist breathing, followed by five days at home in bed. The mean unit value is €$_{03}$ 242 (€$_{07}$ 264). The estimated productivity loss for five days in bed (i.e. €$_{03}$ 440) (€$_{07}$ 480), and emergency-room visit costs (i.e. €$_{03}$ 35) (€$_{07}$ 38) are then added to this estimate. The economic value resulting is €$_{03}$ 717 (€$_{07}$ 782).

Visit to a doctor: asthma and lower respiratory symptoms

Ready *et al*. (2004) found a WTP to avoid a day of asthma attack (excluding medical care and lost productivity costs) of €$_{03}$ 67 (€$_{07}$ 73), €$_{03}$ 139 (€$_{07}$ 152) and €$_{03}$ 295 (€$_{07}$ 322) per day for adult non-asthmatics, adult asthmatics and asthma attack among the respondents' own children, respectively. It is suggested to value additional days using €$_{03}$ 15 (€$_{07}$ 16) as a central unit value. To these values the cost of a general practitioner visit are added. These costs are taken from Netten and Curtis (2000) who give unit values for the resource costs of the general practitioner (GP) in the UK. These vary between €$_{03}$ 25 (€$_{07}$ 27) and €$_{03}$ 42 (€$_{07}$ 46) depending on whether the consultation period is 9.36 minutes or 12.6 minutes (the two unit periods suggested) and whether qualification costs are included. The ExternE project takes the longer period as the relevant. This gives a total of €$_{03}$ 57 (€$_{07}$ 62).

For lower respiratory symptoms a value of €$_{03}$ 38 (€$_{07}$ 41) may be used. This value was derived for the symptom described as "a persistent phlegm cough occurring every half-hour or so and lasting one day". General practitioner costs should be added, giving a total of €$_{03}$ 80 (€$_{07}$ 87).

In the ExternE project is also suggested to value new cases of Asthma €$_{03}$ 60,000 (€$_{07}$ 65,000) per new case. These costs include: loss of income through absence from work or having to change jobs; medical treatment; and pain and suffering.

Restricted activity days from respiratory illness (RAD)

A value of €$_{03}$ 49 (€$_{07}$ 53) per restricted activity day is available from the Ready *et al.* (2004) study. A restricted activity day is defined as a day confined to bed, where there is shortness of breath on slight exertion. To this value the average EU productivity loss of €$_{03}$ 88 (€$_{07}$ 96) per day may be added, dependent on the severity. Thus, one RAD can be valued at €$_{03}$ 49 (€$_{07}$ 53) or €$_{03}$ 137 (€$_{07}$ 149).

Respiratory symptoms in adults and children with asthma

The asthma attack values given in Ready et al. (2004) for adult asthmatics – €$_{03}$ 139 (€$_{07}$ 152) per event and €$_{03}$ 15 (€$_{07}$ 16) per extra day – may be used. For asthma attacks among the respondents' own children the WTP per event was €$_{03}$ 295 (€$_{07}$ 322), and a WTP of €$_{03}$ 31 (€$_{07}$ 34) for each additional day of asthma symptoms.

Respiratory medication use by children and adults

A total unit value of €$_{03}$ 1 (€$_{07}$ 1.09) per day for both adults and children is assumed based on the use of bronchodilators Terbutaline or Albuterol.

Chronic bronchitis (new cases)

This cost category is the second most important (after mortality) component of total damage costs from respiratory illnesses. Chronic bronchitis is characterized by a wide range of severity. While some cases are mild and temporary, chronic bronchitis can be a truly debilitating permanent condition, making it impossible to work or lead a normal life. Some valuation studies, such as Viscusi et al. (1992) are based on severe cases other, such as Abbey *et al.* (1995), are based on light cases(persistent cough or phlegm during at least two months). A study conducted by Krupnick and Cropper (1992) uses an implicitly assumed distribution of case severity. Based on this study, the ExternE project suggest a costs of $€_{03}$ 0.2 ($€_{07}$ 0.22) per million VPF per new case of chronic bronchitis. Together with the VPF of ExternE of $€_{03}$ 1.0 ($€_{07}$ 1.09) million one obtains a unit cost of $€_{03}$ 0.2 ($€_{07}$ 0.22) million.

Other Effects

The Ready *et al*. (2004) study also notes that one cough day is estimated to be $€_{03}$ 41/day ($€_{07}$ 0.45/day). The same value should be applied to minor RAD (restricted activity day) and symptom day (note that this is probably a low estimate for a symptom day as one day with mildly, red watering, itchy eyes and runny nose is valued at $€_{03}$ 53.5 ($€_{07}$ 58). A work loss day is valued according to the discussion of the costs of absenteeism, above, $€_{03}$ 88 ($€_{07}$ 96), with lower and upper bounds being $€_{03}$ 58 ($€_{07}$ 63) and $€_{03}$ 261 ($€_{07}$ 285) respectively.

Additional notes on valuation and useful functions
Capalbo and Heggem (1999) show that the value of a health care facility j can be found with the following formula:

$$V_j = N\sum_{i=1}^{N}\left[f_j(S_i)r_j(S_i)\phi_j(S_i)\right]$$

Where N = population size; $f_j(S_i)$ = value to individual i with characteristics S_i of a one time visit to facility j, $r_j(S_i)$ = use rate of health care facility j for population with characteristics S_i, and $\phi_j(S_i)$ = proportion of the population with characteristics S_i.

Davis (2004) presents evidence that health risks have an impact on housing values. The author compares housing prices in a county of Nevada before and after a severe increase in pediatric leukaemia in 2000. Findings suggest that house prices in areas hit by the increase in pediatric leukaemia are discounted between 14% (fixed effect estimate) and 15.6% (Ordinary Least Square estimate). These values are then used to compute the value of a statistical case of pediatric leukaemia between $\$_{00}$ 3 ($€_{07}$ 3.2) million and $\$_{00}$ 9.2 ($€_{07}$ 9.9) million. These values are comparable to estimates of the value of **cancer** (Gayer et al., 2000 – between $\$_{00}$ 4.3 ($€_{07}$ 5) million and $\$_{00}$ 5 ($€_{07}$ 5.3) million) and mortality risk (Viscusi and Aldy, 2003 – between $\$_{00}$ 4 ($€_{07}$ 4.3) million and $\$_{00}$ 9 ($€_{07}$ 9.6) million).

Alberini (2005) compute two conservative estimates of VSL for Italy based on median WTP for individuals at risk and for the appropriate size of the risk reduction (about 1 in 10,000 a year, and 2.5 in 10,000 a year, respectively, for a 45-year-old and for a 65-year-old). These two VSL figures are equal to $€_{04}$ 1.8 ($€_{07}$ 1.9) million and $€_{04}$1.7 million ($€_{07}$ 1.8). These estimates are in line with the recommended EU-wide figures recommended in the cost-benefit analysis of the Clean Air for Europe program, which are equal to $€_{00}$1 ($€_{07}$ 1.2) million and $€_{00}$ 2 million ($€_{07}$ 2.3 million), respectively.

Summary

Based on the values reviewed in this section we conclude that it is appropriate to value the loss of a statistical life for general causes between $€_{07}$ 1.2 and $€_{07}$ 2.3 million as suggested by the EU for the Clean Air for Europe program. The loss of a statistical life due to cancer or pediatric leukaemia should be attached a greater value due to the evidence provided by Gayer et al. (2000) and Viscusi et Aldy (2003). This value should range between €$_{07}$ 3.2 and €$_{07}$ 9.6 million Euro.

3.1.2 Environment Protection

Environment protection includes the value of ecosystem services in terms of water quality, air quality, soil quality, biodiversity, landscape, wetlands, noise, and bad odours. We could find two studies offering a comparative overview of the value of ecosystem services. The first study is from Pretty et al. (2000). The authors compute the external costs of UK agriculture finding them to be equivalent to £$_{96}$208/ha (€$_{07}$ 315/ha) per hectare arable land and permanent pasture, that is equal to £$_{96}$125/ha (€$_{07}$ 188/ha) per hectare total agricultural land. Table 9 shows negative externalities caused by UK agriculture to the provision of ecosystem services in detail. Only externalities giving rise to financial costs are included.
The second study was carried out in 1997 by Costanza et al. The author finds the value of world ecosystems to be between \$$_{97}$ 16-54 (€$_{07}$ 16-58) trillion per year and gives an overview of values per hectare for different land uses. These values are shown in table 10. To be noticed is that benefits from cropland found by Costanza et al. equal €$_{07}$ 98/ha (world average) while Pretty et al. find that in the U.K. Agricultural Land generates external costs equal to €$_{07}$ 188/ha. While these figures seem to suggest that Agricultural land uses are associated to net costs, it is obvious that agricultural activities are one of the most important socio-economic activity sustaining human life. We use this example to warn the reader against adding values found in different studies especially when the analysis is carried out in different regions. Furthermore, accounting of costs and benefits often imply a selection based on available values and valuation methods. Important factors may be not included simply because of missing data. Finally, with respect to the specific case of agriculture, we have a problem of discontinuity given by the fact that humans need a minimum amount of food to survive. Value concepts based on willingness to pay and economic growth are deemed to underestimate the true value of agriculture because as household income and GDP grow, the percentage of income spent on food and the percentage of GDP from agricultural activities usually decreases.

3.1.2.1 Water Quality

Water quality can be evaluated in terms of its effect on house prices or property values or in terms of individuals' willingness to pay (WTP) to obtain water quality improvements or avoid water quality deterioration. The first approach is followed for example by Page (1993), Dotzour (1997), Des Rosiers et al. (1998), and Leggett and Bockstael (1999). These studies were not carried out in Europe. Page (1993) analyzing various case studies in the U.S., shows that groundwater contamination affects industrial and commercial property values but nor residential one (see table 10). Jackson (2005) finds that groundwater contamination increases investment risk associated to industrial and commercial properties as perceived by investors. Dotzour (1997) specifies the contaminated property value as follows:

Contaminated value = Uncontaminated value – Cleanup Cost – Public Liability – Stigma

Des Rosiers et al. (1998) in a study carried out in Quebec City find that water related health hazard decrease house prices from 5.2 to 10.3% in the upper third segment of the housing market. Leggett and Bockstael (1999) in a study carried out in Chesapeake Bay (U.S.), find that water quality can have an impact on residential property prices: A change of 100 fecal coliform counts per 100 mL is estimated to produce about a 1.5% change in property prices. Johnston et al. 2005 offer a meta-analysis of studies following the second approach to value water quality improvement for recreational purposes. The list of studies and valuation results are shown in table 11. The author suggests the use of the water quality ladder developed by resources for the future to reconcile different water quality improvement scenarios. The authors also note that after reconciliation, considerable differences in WTP across studies remain so that benefit transfer remains questionable. Summarizing, the literature addressing water quality issues seems to focus on two valuation issues: effects of groundwater contamination on property prices and individuals' WTP for recreational water quality improvements. Issues related to water demand and supply are discussed in this report under the category "Electricity, Gas, Water and Fuel supply", while landscape attributes of water bodies are discussed under "landscape".

Additional notes and Useful functions

Hascic and Wu (2006) estimate impacts of land use changes on water quality using the following empirical model:

$$\ln(CONVWQ_i) = \ln N_i^c + \beta_0 + \beta_1' I_i^c + \beta_2' P_i^c + \beta_3' d_i^c + \varepsilon_i^c$$

where i is the watershed index, N_i^c is the total number of samples taken to measure conventional water quality, I_i^c is a vector of land- and chemical-use variables affecting conventional water pollution, P_i^c is a vector of physical characteristics measuring the vulnerability of individual watersheds to conventional water pollution, d_i^c is a vector of spatial dummies, and ε is an error term. A similar model used to estimate land use impacts on toxic water quality. The *conventional ambient water quality* indicator (CONVWQ) measures the number of surface water samples in a watershed with concentrations of one or more of the four conventional water quality measures (phosphorus, ammonia, dissolved oxygen, pH) exceeding the national reference levels. The *toxic ambient water quality* indicator (TOXICWQ) measures the number of surface water samples in a watershed with concentrations of one or more of the four toxic pollutants (copper, nickel, zinc, chromium) exceeding the national chronic levels. Predicted levels of water quality are then used to explain the change in the *species at risk* indicator measures the number of aquatic and wetland species (plants and animals) at risk of extinction in a given watershed in 1996. The authors find that the level of conventional water pollution in a watershed is significantly affected hv the amount of land allocated to intensive agriculture and urban development, while the level of toxic water pollution is significantly affected by the amount of land allocated to transportation and mining. Per acre impacts are shown in table 10.

3.1.2.2 Air Quality

Changes in air quality include changes due to greenhouse gas emissions, particulate matter (PM) and other fuel emissions. The major greenhouse gases are water vapor, carbon dioxide (CO_2), methane (CH_4), and ozone (O_3). Other greenhouse gases are nitrus oxide (N2O), sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and chlorofluorocarbons (CFCs). Other fuel emissions include Benzene, Benzo-[a]-pyrene, 3-butadiene, Diesel particles.

Changes in air quality can be evaluated using a bottom up or a top down approach. The bottom up approach targets single impacts of single pollutants while top down approaches try to valuate overall changes in air quality (usually expressed as changes in total suspended PM) in terms, for example, of changes in related marketed goods such as houses (hedonic price modelling) or in terms of an elicited willingness to pay for those changes (contingent valuation studies, discrete choice models).

Top down approach

As example of top down approach: A meta-analysis by Smith and Huang (1995) of 37 studies conducted in the period 1967-1984 estimating the marginal willingness to pay (MWTP) for reducing particulate matter from hedonic property value models shows that

the MWTP for a one unit reduction in total suspended particulates (in microorganism per cubic meter) is $109.90 on average while the median is $ 22.40. Estimates are sensitive to market conditions and econometric approach used (ordinary least square or minimum absolute deviation estimators).
A Meta analysis by Banzhaf and Smith (2003) show instead the sensitivity of welfare estimates derived from discrete choice models to assumptions about the choice set. In an analysis of housing in the Loa Angeles area from 1989 to 1994, the authors find that estimates of the willingness to pay for an improvement in ozone (measures as number of days without an exceedance of the national ozone standards) indicates that the time window dimension of the choice set has a significant, but small effect. Geographic boundaries also appear to influence the results. Finally, the budgetary dimension of the choice set is quite important to both estimation and welfare measurement.
Eurostat collects data on air emissions for main air pollutants. Emissions for the year 2000 for selected aggregates are shown in table 12.

Bottom up approach

The bottom up approach instead requires the identification of an impact pathway linking specific sources of changes in air quality to specific effects. The impact pathway proposed by the ExternE project for a bottom up approach for selected air pollutants is shown in table 13. The monetary valuation of Human Health effects was described in sub-section 3.1.

3.1.2.3 Soil Quality

See Part B of this report on Brownfield Remediation.

3.1.2.3 Odours

See Part B of this report.

3.2 Housing and Amenities

Household value housing characteristics and associated amenities. The literature using a hedonic approach to valuing amenities and housing characteristics shows that the house price is indeed responsive to changes in those characteristics and amenities services. A Metaanalysis of housing characteristics based on US studies is offered by Sirman et al. 2006. The authors value nine housing characteristics: square footage, lot size, age, bedrooms, bathrooms, garage, swimming pool, fireplace, and air conditioning. The authors show that the value of these characteristics varies considerably by geographical location while time, type of data and model specification have a limited impact. To identify the value of housing characteristics and amenities we formed a value table based on results of 80 hedonic studies. The value table has the following format: year the study was published, reference, name of journal/book the article was published in, year the analysis refers to, location, dependent variable, mean and standard deviation of the dependent variable, independent variable name, independent variable definition, classification (this includes several fields), functional form used, estimated coefficient, standard error, t-ratio, significance, number of observations, Adjusted R-square. The dataset includes mostly non European studies. European studies included were carried out in the following cities: Paris (France), Glasgow (UK), England and Wales (UK), Joensuu (Finland).
Our table shows 28 value coefficients for amenities (change in house price due to the presence of an amenity). Values were obtained for the following amenities: playground, golf course, tennis court, clubhouse, cemetery, and landscaping. The table also shows 2900 estimates for housing characteristics which are divided mainly into: age of the house, size, interior house characteristics,

exterior house characteristics, style, time of sale, location, characteristics of the neighbourhood. Table 16 shows Hedonic prices and price elasticities for urban amenities. These prices show the impact of the amenity on property values. For example the MWTP of 255 for reducing the fraction of poorly performing peers by 1% implies that a policy achieving this 1% reduction in a town with 25000 landlords is worth 6.375 million.
Furthermore, assuming that an average working individual will commute 230 days per year forever, and using a discount rate of 3.5%, the hedonic price of 345 E associated with a one minute reduction in commuting time is consistent with a value of the minute of some 5 cents (3 E for an hour), which is about 50% of the French net minimum hourly wage rate.

Additional Notes and Useful functions

Goodman (2005) estimates for the U.S Housing supply elasticities between 1.26 and 1.42. De Rieux et al. (2005) defines the costs of home ownership and investor returns as follows:

Operating Costs = Property Taxes -Insurance - Maintenance - Depreciation

Investor Return = Rent - (Mortgage Interest - Operating Costs) - Capital Gains

3.3 Security and Safety

Security and safety can be valued in terms of individuals' WTP for a reduction in crime rate, or in terms of impacts on house prices of the occurrence of a natural disaster such as an earthquake, a hurricane or flood. Table 17 show some house price elasticities with respect to crime rates per 1000 people. All values are very close to zero and the majority of values is negative. Estimates of impacts of natural disasters on house prices are negative. A study from Kreimer et al. (2003) shows that in developing countries catastrophe victims cause economic losses between 0 and 15.6% of GDP.

Hultkrantz et al. (2006) estimates the value of improved road safety in terms of reduction of a severe statistical accidents between SEK 7.9 and 20.8 million and a value of statistical life (VSL) of SEK 53 million. Blaeij et al. (2003), performs a meta-analysis of road safety using 85 VSL point estimates. The authors show that these estimates are sensitive to the valuation methodology chosen and the frame offered to respondents (public vs private). See table 8 for additional VSL estimates.

3.4 Social Coesion

Indicator: Dissimilarity/segregation Index (Massey and Denton, 1988)

Definition: Massey and Denton (1988) recognize five distinct dimensions of segregation: evenness, exposure, concentration, centralization and clustering. The dissimilarity index measures evenness.
This index measures the extent of ethnic/economic segregation in a metropolitan area or city:

Ethnic segregation:

$$D = \frac{\sum N_i |b - b_i|}{2Nb(1-b)}$$

where D = ethnic dissimilarity index; N_i = neighbourhood population; N = metropolitan area / city population; b_i = percentage of ethnic group in neighbourhood i (i.e. % black or % immigrant or other); b = percentage of ethnic group in the metropolitan area or city. This index is equal to 0 where all neighbourhoods have the same racial mix; it is equal to 1 when all members of the ethnic group analyzed live in the same neighbourhood.

Economic segregation:

$$J = \frac{\left(H^{-1}\sum H_n(\bar{y}_n - \bar{y})^2\right)^{1/2}}{\left(H^{-1}\sum (y_h - \bar{y})^2\right)^{1/2}}$$

where J = economic dissimilarity index; h indexes households; n indexes neighbourhoods; y = income; H = number of households; the bar signifies a mean and the lack of a subscript signifies a metropolitan or city level variable.

Notes on benefit transfer: This index is scale dependent. Larger residential districts usually exhibit a higher degree of dissimilarity than smaller districts (Gordon and Monastiriotis, 2006; Schnidler, 2007). Scale dependence seems to be lower in smaller cities (Krupka, 2007). Low dissimilarity in residential district does not mean low dissimilarity at school. In a study of the city of Copenhagen, Schindler (2007) finds that segregation (or dissimilarity) at school depends on the availability of private schools and the difference in quality and cultural background between private and public schools. Yet Gordon and Monastiriotis (2006) find that educational outcomes are only partly affected by neighbourhood effects for particular population characteristics.

Additional Notes and Useful Functions

Musterd (2006) finds no evidence that the level of urban socio-economic segregation is associated to the level of attractiveness of a city for businesses. Weak evidence is found that cities with higher socio-economic segregation of the upper class is more attractive for employees. This study encompasses the following cities: Copenhagen, Berlin, Manchester, Milan, Amsterdam and Oslo using data form the Urban Audit and the European City Monitor.
Kennet and Forrest (2006) report on results of the European Social Survey showing that social cohesion varies considerably across countries. Some examples of indicator of social cohesions derived from this survey are: percentage of population involved in voluntary work; perception of safety; attitudes toward opening borders to immigrants.
Gordon and Monastiriotis (2006) find that greater individual inequality in more segregated areas is mainly due to positive impacts of segregation for more advantaged groups, rather than negative impacts for the most disadvantaged. The authors also show that concentrating employment in a single centre contributes to segregation of elderly. Föbker and Grotz (2006) in a study of the city of Bonn, Germany, show that to grant a socially integrated life to individuals over 60 years of age, basic supply and leisure facilities in their neighbourhood, and a railbound public transport connection to the city should be in place.
Gordon and Monastiriotis (2006) in their analysis also show that employment in a single centre contributes to segregation of unemployed individuals. Dixon and Meen (2006) highlight that segregation of poor individuals contributes to an intergenerational persistence of poverty and so called “poverty traps” emerge. Neighbourhood characteristics may contributes to the establishment of poverty traps through their influence on educational achievement and future labour market performance.

PLUREL

3.5 Education

Indicator: Elasticity of house prices with respect to school expenditure

Brasington and Haurin (2006) analyze 310 US school districts finding that households value proficiency test scores more than value added measures of school quality. The elasticity of house prices with respect to per pupil school expenditure is 0.49.

Indicator: Elasticity of house prices with respect to test scores.

Definition: The school test score is the mean elementary school math and reading score over the period t through t+1, after subtracting the mean and dividing by the student-level standard deviation by grade. (The resulting score is in student-level standard deviation units.)

Brasington and Haurin(2006) find that an increase in one point standard deviation in test scores increase house prices by 7.1 %. Kane (2003) analyzes the elasticity of house prices with respect to Math and reading test scores. For the full sample Kane finds that a one student-level standard deviation difference in school test scores is associated with a 39.6 % increase in housing values.

Downes and Zaibel in a study carried out in Chicago with data from 1987 to 1991, find the elasticity of house prices with respect to test scores to be close to 1.

Notes on Benefit Transfer: these value vary with the distance of the house to the school, in Kane for example, schools within 2000 Feet have an elasticity of 62.7%.

Indicator: Household WTP to increase public school quality as % of current educational budget.

Stair et al. (2006) in a study carried out in Rural areas of Pennsylvania, find that households would be WTP 25% of the current educational budget to increase test performance by 10% in test administered between grades 6 and 12.

Notes on Benefit Transfer: households with lower income and lower connections to public schools are willing to pay less.

Indicator: Homeowners WTP to avoid educationally poor neighbourhoods.

Definition: house price elasticity with respect to the educational level of neighbourhood residents.

Gibbons (2003) find for England and Wales a price elasticity with respect to a 1% increase in the proportion of higher – educated residents in a community is 0.24%.

Additional Notes and Interesting Functions
Nechyba (2003) defines the following school production function:

$$s = f(x,q) = x^{\beta}q^{1-\beta}$$

With x = per pupil expenditure; q = average peer input.

Brasington (2003) estimate a supply curve of public school quality. The price of a unit of public school quality is derived using hedonic estimations and defined as follows:

$$\frac{\partial houseprice}{\partial testscore} = \delta * houseprice$$

Where δ is the hedonic estimate with the ln of prices used as dependent variable.

The estimated price is then inserted in an estimation of the supply of public schooling. The supply of public schooling is measured in terms of test scores that are regressed on the implicit price of school quality and other variables. The supply elasticity is found to be 0.14.

3.6 Recreation, Culture and Religion

See Part B of this Report

3.7 Electricty, Gas, and Water Supply

3.7.1 Electricty and Gas Supply

The literature found focuses mainly on costs associated to energy supply.
Filippini and Wild estimate an average-cost function for a panel of 59 Swiss local and regional electricity distribution facilities. Electricity distribution costs are shown by Burns and Weyman –Jones (1996) to depend on the following factors:

1. the maximum demand on the system;
2. the total number of customers served;
3. the type of consumer;
4. the dispersion of the consumers;
5. the size of the distribution area;
6. the total kWh sold;
7. system security;
8. the length of distribution line; and
9. the transformer capacity.

The average cost function estimated by Filippini and Wild is the following:

$$AC = 9.2284 - 0.0063Y + 0.000003Y^2 + 0.008PL + 0.0409PC + 1.5910HGRID + 4.4542LVSH -$$
$$- 0.005AVGL - 11.2375LF - 0.3782CD + 0.0076CD^2 + 5.0627AGSH + 7.4453FOSH + 2.0518UPSH -$$
$$+ 9.7348OTSH + 0T + \varepsilon$$

where *AC* represents average cost per kWh and *Y* is the output represented by the total number of kWh transported on the medium-voltage grid. *PL* and *PC* are the prices of labor and capital, respectively. *HGRID* is a dummy variable to separate distribution utilities that are also operating a high-voltage grid. *LVSH* represents the share of electricity that is delivered on the low-voltage network. This variable considers the differences among the utilities in terms of customer structure. *AVGL* is the average consumption per low voltage customer. *LF* is the load factor and *CD* is the customer density measured in customers per hectare of settlement land. *AGSH* represents the share of agricultural land, *FOSH* represents the share of forest land and *UPSH* indicates the share of unproductive land with respect to the total size of the service area, respectively.4 *OTSH* is a variable used to control for outputs other than the distribution of electricity that are included in the accounting data of electric utilities.5 We use the share of 'other revenues' on total revenues as output indicators for these activities. *T* is a time variable which captures the shift in technology representing change in technical efficiency.

Hamilton and Schwann (1995) find that power lines have a negative impact on house prices of due to visual externalities (5.7% of the house value in Vancouver for properties within 200 meter distance). Sims and Dent (2005) find similar results for the UK (a reduction between 6 and 17% for properties within 100 meters from a high voltage pylon). Boxall et al. (2005) find that oil and natural gas facilities have a negative impact on house values for properties within 4 Km distance (between 3.8% and 4.3% depending on the index used). The study was conducted in Alberta, Canada.

3.7.2 Water Supply

Water has several dimensions such as quality, quantity, timing and location. In this section we consider valuation of water quantity. The value of water quality improvement is discussed in section 3.1.2. of this report (part A).

The value of water for different uses has been investigated by Frederick et al. (1997). The authors analyse about 500 value estimates for domestic, irrigation, industrial processing, thermoelectric power generation, hydropower, recreation/fish and wildlife habitat, navigation and waste disposal. Frederick et al. find that the most valuable use of water is the domestic one. Estimation of such value start with the estimation of a demand curve, the value of water is then given by the difference between the area under the water demand curve for the marginal unit of water (which is the consumer willingness to pay for a unit of water) minus treatment and delivery costs. The use values of water are shown in table 18. The author observe that values vary by regions.

A meta-analysis of price and income elasticities of residential water demand and of their influence factors is offered in Dalhuisen et al. (2003). The authors find that cross study variation of these elasticities can be explained in terms of differences in theoretical microeconomic choice approaches, differences in spatial and temporal dynamics, as well as differences in research design of the underlying studies. The occurrence of increasing or decreasing block rate water pricing systems are also important. With respect to price elasticities, the use of the discrete-continuous choice approach is relevant in explaining observed differences. The authors analyse 64 studies, from which 314 price elasticity estimates and 162 Income elasticities estimates were derived. *P*rice elasticities range between -7.47 and 7.9, the mean value being -0.41 (standard deviation of 0.86). The distribution of income elasticities has a mean of .43 with a standard deviation of 0.79. European studies offer significantly lower estimates than studies carried out in the U.S.. for both price and income elasticities. The coefficient in the meta-regression analysis is 0.29 for price elasticities (this implies a lower elasticity value by 0.29 points in absolute terms because price elasticities are negative). The estimated meta-regression coefficient for income elasticties varies between -1.08 and -0.77. Both prices and income elasticities are higher in areas with higher GDP per capita, by between 0.14 and 0.4 points for price elasticities and 0.06 points for income elasticities.

3.8 Transport

Costs are usually divided into two categories: market-priced costs and non-market costs. Market-priced costs are born both by users and non-users of the transport network as well as by transportation and non-transportation agencies. Some examples are given in table 19.

An example of the relative importance of the different categories of costs and benefits for transport infrastructure projects is shown by Lindberg (1992) in an analysis of 53 projects in Sweden:
time gains 42%,
reduced accident risks 26%,
reduced vehicle operating costs 12%,
other cost reductions 20%.

Costs vary depending on location (country), year, time of the day (peak vs off-peak), travel purpose (work, freight, other), transport mode (car, bus, truck, rail, air, water). Transport costs are usually indicated in units of national currency per vehicle kilometre (or mile), or in unit of national currency per hour.

Evaluation methods: Production Function approach, Cost Benefit Analysis calculations

Production function approach

Indicator: Output (GDP) Elasticity with respect to capital investments in transport infrastructure

Definition: Output elasticities represent the percent change in GDP due to a 1% increase in infrastructure investments.

Notes on benefit transfer: Chandra and Thompson (2000) find that the impact of a new highway on industry earnings varies considerably across industry types (manufacturing industries gain while farming, retailing and government shrink), locations (economic activity is drawn away from counties adjacent to the highway to counties where the highway passes directly through) and time at which the highway was build (new highways bring a gain in economic activity in the range shown in table 20, this gain shrinks over time and it becomes a loss after 25 years).

Cost Benefit Analysis Calculations:

Indicator: Value of travel time savings (VTTS) as percent of hourly wage

Definition: percent of hourly wage an individual is willing to give up to save 1 hour time.

Notes on benefit transfer: According to a meta-analysis conducted over 53 studies by Zamparini and Reggiani (2007), the value of travel time savings seems to be significantly related to trip purpose (positively related to business trip) and transport mode (positively related to air transport). The VTTS is not significantly related to the geographic location of the study and to GDP per capita. The model used by the authors is able to explain 26,84%.

Values are shown in table 21 and 22.

Indicator: Willingness to contribute to the subsidization of a public transport service (Roberto Roson, Italy 2001)

Indicator: Impact of increased investment in transport infrastructure on house prices (Mikelbank, US-Ohio, 2005)

Indicator: Value of accessibility to railway stations

Definition: Effect of distance to railway stations on house prices in % increase in house price per kilometre distance reduction.

Notes on Benefit transfer: Gibbons and Machin (2005) show that the value of accessibility decreases rapidly for houses located more than 2 km distance from the rail station.

Indicator: typical short-run average variable social costs of urban automobile travel
Definition: average social variable costs per vehicle mile

Notes on benefit transfer: Values require assumptions about typical speed, typical trip length, the value of life, and the wage rate. In Small (1997) these values are: 40 miles/hour, 8,5 miles one-way, $4,46 million, and $11,58 respectively.

Indicator: Transport demand elasticity

Definition: percent change in number of trips or person-km due to a 1 % change in travel cost.

Notes on benefit transfer: Nijkamp and Pepping (1998) in a meta-analysis of 12 studies find evidence that demand elasticity values vary with research method, country, number of competitive transport modes, and type of data collected (time series, cross section, panel). See Table 24 for some transport demand elasticity values.

Indicator: Unit Costs of Paved Roads Construction in International 1985 $ per kilometre are shown in Table 25.

4 Conclusion

In this report urban, peri-urban and rural service supply categories are identified and a classification according to NACE, COIFOG and COICOP classes used in Eurostat national accounts is offered. We introduce the basic concept of economic value and give a brief overview of monetary valuation techniques commonly used to identify this value. The information is organized according to a general conceptual framework consistent to the European Environmental Agency (EEA) ecosystem and land cover accounts, available empirical evidence, built for the purpose of cost-benefit analysis of land-use strategies.

A literature review is carried out for several services, which focuses on valuation studies. Tables of values associated to these services are shown at the end of this report. In general it can be concluded that values found in the literature usually vary by space, time, and research methodology applied. Due care must be taken when comparing values from different studies. Double counting issues may arise when adding or subtracting costs and benefits from different studies.

Table 1. Three-layered Land Cover Classes (CORINE)

First Layer	Second Layer	Third Layer
Artificial Surfaces	Urban Fabric	Continuous Urban fabric
		Discontinuous Urban Fabric
	Industrial, Commercial or transport units	Industrial or commercial units
		Road and rail networks and associated land
		Port areas
		Airports
	Mine, dump and construction sites	Mineral extraction sites
		Dump sites
		Construction sites
	Artificial, non-agricultural vegetated areas	Green urban areas
		Sport and leisure facilities
Agricultural areas	Arable land	Non-irrigated arable land
		Permanently irrigated land
		Rice fields
	Permanent crops	Vineyards
		Fruit trees and berry plantations
		Olive groves
	Pastures	Pastures
	Heterogeneous agricultural areas	Annual crops associated with permanent crops
		Complex cultivation patterns
		Land principally occupied by agriculture, with significant areas of natural vegetation
		Agro-forestry areas
Forest and semi natural areas	Forests	Broad-leaved forest
		Coniferous forest
		Mixed forest
	Scrub and/or herbaceous vegetation associations	Natural grasslands
		Moors and heathland
		Sclerophyllous vegetation
		Transitional woodland-shrub
	Open spaces with little or no vegetation	Beaches, dunes, sands
		Bare rocks
		Sparsely vegetated areas
		Burnt areas
		Glaciers and perpetual snow

Table 1. Continued: Three-layered Land Cover Classes (CORINE)

First Layer	Second Layer	Third Layer
Wetlands	Inland wetlands	Inland marshes Peat bogs
	Maritime wetlands	Salt marshes Salines Intertidal flats
Water bodies	Inland waters	Water courses Water bodies
	Marine waters	Coastal lagoons Estuaries Sea and Ocean

Table 2. Land functional categories: some examples.

Functional category	Associated goods and services	Economically valuable changes
Regulation	Climate regulation Soil retention and formation Disturbance prevention through regulation of noise and bad odours Gas, Water and Energy supply Transport Telecommunications Commerce Waste treatment	Increased quality Reduced nuisance
Habitat	Housing Health Security and Safety Social protection Recreation	Increased quality Increased size
Production	Food, Manufactured Goods, Genetic and Medicinal resource	Increased quantity
Information	Aesthetic, Spiritual, Cultural and artistic information Cultural heritage Education	Increased quantity Increased quality

Table 3. Land Use change Classes and economically valuable changes

Classes
Urban land management
Urban residential sprawl
Sprawl of economic sites and infrastructures
Agriculture internal conversion
Conversion from other land cover to agriculture
Withdrawal of farming
Forests creation and management
Water Bodies creation and management
Change due to natural and multiple causes

Table 4. Structure of Capital and Labour

Manufactured Capital	Non-Manufactured capital	Financial Capital	Labour Supply
Networks: Transport, Telecommunications	Forests	Household Disposable Income	High skilled
Police Stations Hospitals	Biodiversity Wetlands	Household savings	Medium skilled
Other Facilities: Educational, Recreational, Cultural, Industrial, Commercial, Residential, Recreational, Criminal	Water bodies	Tax returns	Low skilled
Power/Water/Gas lines	Mineral Extraction Sites		

Table 5. Urban Peri-urban and rural service supply: identification and linkage with Eurostat economic account

Functional category	Good and service supply	NACE (Industry)	COICOP (Households)	COFOG (government)
Habitat	Health and environment protection including waste management	N85.1 Human Health Activites N85.2 Veterinary Activities O90 Sewage and refuse disposal, sanitation and similar activities	cp06 Health cp0442 Sewerage collection	gf07 Health gf05 Environment protection
	Housing and amenities	H Hotels and restaurants K70 Real estate activities	cp11 Restaurants and hotels cp041 Actual rentals for housing cp042 Imputed rentals for housing cp043 Maintenance and repair of the dwelling	gf0606 Housing and community amenities n.e.c. gf0601 Housing development gf0602 Community development gf0605 R&D Housing and community amenities
	Security and safety	L75.22 Defence L75.23 Justice and judicial affairs L75.24 Public security, law and order activities L75.25 Fire service activties		gf02 Defence gf03 Public order and Safety
	Social Environment	L 75.1 Administration of the State and the economic and social policy of the community L75.3 Compulsory social security N85.3 Social work activites	cp124 Social Protection	gf10 Social Protection
Information	Education	M Education	cp10 Education	gf09 Education
	Recreation, Culture and religion	O92Recreational, cultural and sporting activities	cp09 Recreation and culture	gf08 Recreation, culture and religion

Table 5 – Continued. Urban Peri-urban and rural service supply: identification and linkage with Eurostat economic account

Functional category	Good and service supply	NACE (Industry)	COICOP (Households)	COFOG (government)
Production	Goods	A Agriculture, Hunting, Forestry B Fishing C Mining and Querrying D Manufacturing F Construction K71.3 Renting of other machinery and equipment K71.4 Renting of personal and household goods n.e.c.	cp01 Food and non-alcoholic beverages cp03 Clothing and footwear cp02 Alcoholic beverages, tobacco and narcotics cp05 Furnishings, household equipment and routine maintenance of the house cp121 Personal care cp122 Prostitution cp123 Personal effects n.e.c.	gf0402 Agriculture forestry, fishing and hunting gf0404 Mining, manufacturing and construction gf0407 Other industries

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Table 5 – Continued. Urban Peri-urban and rural service supply: identification and linkage with Eurostat economic account

Funtional category	Good and service supply	NACE (Industry)	COICOP (Households)	COFOG (government)
Regulation	Electricity, Gas, Water and Fuel supply	Electricity, gas and water supply G50.5 Retail sale of automotive fuel	cp0441 Water supply cp045 Electricity, Gas and other fuels	gf0603 Water supply gf0403 Fuel and energy
	Commerce	G 51 Wholesale trade and commission trade except of motor vehicles and motorcycles G52 Retail sale, except of motor vehicles and motorcycles, and repair of personal and household goods		
	Other services	J Financial intermediation L75.21 Foreign Affairs O91 Activities of membership organizations n.e.c. O93 Other service activities	cp125 Insurance cp126 Financial services n.e.c. cp127 Other services n.e.c.	gf01 General public services gf0401 General economic, commercial and labour affairs gf0408 R&D Economic affairs gf0409 Economic affairs n.e.c.
	Post and Telecommunications	I64 Post and Telecommunications	cp08 Communications	gf0406 Communication
	Transport	G50.1-4 Sale, maintenance and repair of motor vehicles and motorcycles I60 Land transport and transport via pipelines I61 Water transport I62 Air transport I63 Supporting and auxiliary transport activities; activities of travel agencies K71.1 Renting of automobiles K71.2 Renting of other transport equipment	cp07 Transport	gf0405 Transport gf0604 Street lighting

Table 6: Summary of Health Impacts

Pollutant/Hazard	Health Impact	Reference
Air Pollution		
Particulate Matter (PM)	Heart disease, respiratory illnesses (chronic bronchitis, pneumoconiosis, asthma).	Buchdahl, et al, (1996); Friends of the Earth (1997); EPA (2002); EPA (2003); Krzyzanowski, et al, (2005)
Nitrogen Dioxide (NO_2)	Lung irritation, viral infection, asthma, chest tightness.	
Carbon Monoxide (CO)	Fatigue, nausea, unconsciousness, death by asphyxiation.	
Benzene (C_6H_6)	Weakening of the immune system, nausea, unconsciousness, anaemia, leukaemia.	
Ozone (O_3)	Impaired lung function, asthma, chest pains, coughing, irritation of the eyes/nose.	
Water Contamination		
Bromide	Cancer, nephrotoxicity (kidney poisoning).	Lack (1999); McDonagh, et al, (2000); Nixon (2004)
Fluoride	Fluorosis (mottling of the teeth).	
Nitrate	Methemoglobinemia (blue baby syndrome), cancer.	
Phosphate	Osteoporosis (reduced bone mineral density).	
Sulfate	Diarrhoea and gastrointestinal disorders.	
Lead (Pb)	Anaemia, damage to the nervous and renal (kidney) systems.	
Mercury (Hg)	Damage to nervous, endocrine (hormone) and renal systems, brain damage, death.	
Magnesium (Mg)	Diuretic, cathartic and laxative effects.	
Transport		
Cars	RTA could be reduced by using public transport and/or by walking/cycling.	Saelensminde (2002)
Vehicle Usage	Insufficient physical exercise associated with higher risk of coronary heart disease, cancer, hypertension, diabetes, osteoporosis, obesity, anxiety, clinical depression.	Frank and Engelke (2001)

Table 7: Health care expenditure as % of GDP (year 2005): Eurostat.

Country	Health
Czech Republic	6.87
Denmark	8.77
Germany	10.26
Estonia	4.98
Spain	7.97
France	10.78
Cyprus	5.81
Lithuania	5.73
Luxembourg	7.58
Netherlands	9.19
Poland	5.85
Portugal	9.69
Romania	5.16
Slovenia	8.17
Switzerland	11.42
United States	14.97

Table 8: Monetary values associated to changes in Health status: respiratory illnesses, cancer and pediatric leukemia.

Indicator	Measurement unit	Median Values for the EU	Country	Reference
Value of a statistical life (VSL)	2000 million Euro reduction of risk 1:10000 for 45 year old	0.980	UK, FR, IT	ExternE (2003, 2005)
Value of a statistical life (VSL)	2000 million Euro reduction of risk 2.5:10000 for 65 year old	2	UK, FR, IT	ExternE (2003, 2005)
Value of a statistical life (VSL)	2002 million Euro reduction of risk 1:10000 for a 45 year old without cardiovascular or respiratory problems	1.052	UK, FR, IT	ExternE (2003, 2005)
Value of a statistical life (VSL)	2003 million Euro reduction of risk 1:10000 for a 45 year old without cardiovascular or respiratory problems	1.824	IT	Alberini (2005)
Value of a statistical life (VSL)	2003 million Euro reduction of risk 1:10000 for a 65 year old without cardiovascular or respiratory problems	1.008	IT	Alberini (2005)
Value of a statistical life (VSL)	2003 million Euro reduction of risk 1:10000 for a 65 year old with cardiovascular or respiratory problems	2.740	IT	Alberini (2005)
Value of a statistical life (VSL)	2003 million Euro reduction of risk 5:10000 for a 45 year old without cardiovascular	0.754	IT	Alberini (2005)

	or respiratory problems			
Value of a statistical life (VSL)	2003 million Euro reduction of risk 5:10000 for a 65 year old without cardiovascular or respiratory problems	0.417	IT	Alberini (2005)
Value of a statistical life (VSL)	2003 million Euro reduction of risk 5:10000 for a 65 year old with cardiovascular or respiratory problems	1.132	IT	Alberini (2005)
Value of a statistical life year (VOLY) for acute mortality	2002 Euro	75000	UK, FR, IT	ExternE(2003, 2005)
VOLY for chronic mortality	2002 Euro	55800	UK, FR, IT	ExternE(2003, 2005)
Hospital admissions	2003 Euro per admission	468	BE, FR, DE, IT, NL, UK	Ready et al. (2004)
Productivity loss	2003 Euro per case/day	88	BE, FR, DE, IT, NL, ES, UK	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	323	EU (BE, FR, DE, IT, NL, ES, UK)	ExternE (2003) Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	241	BE	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	375	FR	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	321	DE	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	256	IT	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	390	NL	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	345	ES	Ready et al. (2004)
Hospitalization costs	2003 Euro per inpatient/day (mean)	330	UK	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	23	EU (BE, FR, DE, IT, NL, ES,)	ExternE (2003) Ready et al.

				(2004)
Emergency room	2003 Euro per inpatient/day (mean)	19	BE	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	29	FR	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	24	DE	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	20	IT	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	30	NL	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	27	ES	Ready et al. (2004)
Emergency room	2003 Euro per inpatient/day (mean)	96	UK	Ready et al. (2004)
Emergency Room Visit for respiratory illness	2000 Euro per visit	670	PT,ES,NL,UK,NO	Ready et al. (2004)
General Practicioner visits: Asthma Lower respiratory symptoms	2000 Euro per consultation	 53 75	PT,ES,NL,UK,NO	Ready et al. (2004)
Respiratory symptoms in asthmatics: Adults Children	2000 Euro per event	 130 280	PT,ES,NL,UK,NO	Ready et al. (2004)
Respiratory medication use – adults and children	2000 Euro per day	1	PT,ES,NL,UK,NO	Ready et al. (2004)
Restricted activity days	2000 Euro per day	130	PT,ES,NL,UK,NO	Ready et al. (2004)
Cough day	2000 Euro per day	38	PT,ES,NL,UK,NO	Ready et al. (2004)
Symptom day	2000 Euro per day	38	PT,ES,NL,UK,NO	Ready et al. (2004)
Cost of absenteism	2000 Euro per day	82	PT,ES,NL,UK,NO	Ready et al. (2004)
Minor restricted activity day	2000 Euro per day	38	PT,ES,NL,UK,NO	Ready et al. (2004)
Chronic bronchitis	2000 Euro per case	190000	PT,ES,NL,UK,NO	Ready et al. (2004)
Pediatric leukemia	2000 Million Euro per statistical case	2.8 -8.5	US	Ready et al. (2004)
Cancer	2000 Million Euro per statistical case	4 – 4.6	US	Ready et al. (2004)

Source: EnternE (2003) and our add-ins.

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Table 9. Irreversible costs of UK Agriculture

The annual total external costs of UK Agriculture, 1996 (range values for 1990±1996)		
Cost category UK	**(1996 £ per hectare agricultural land*)**	**(€2007 per hectare agricultural land*)**
1. Damage to natural capital - water		
1a. Pesticides in sources of drinking water	6	10
1b. Nitrate in sources of drinking water	1	1
1c. Phosphate and soil in sources of drinking water	3	4
1d. Zoonoses (esp. Cryptosporidium) in sources of drinking water	1	2
1e. Eutrophication and pollution incidents (fertilisers, animal wastes, sheep dips)	0.32	0.48
1f. Monitoring and advice on pesticides and nutrients	1	1
2. Damage to natural capital - air		
2a. Emissions of methane	15	23
2b. Emissions of ammonia	3	4
2c. Emissions of nitrous oxide	39	60
2d. Emissions of carbon dioxide	3	4
3. Damage to natural capital – soil		
3a. Off-site damage caused by erosion	1	1
3b. Organic matter and carbon dioxide losses from soils	4	7
4. Damage to natural capital - biodiversity and landscape		
4a. Biodiversity/wildlife losses (habitats and species)	1	2
4b. Hedgerows and drystone walls	5	8
4c. Bee colony losses	0.11	0.16
4d. Agricultural biodiversity	+	+
5. Damage to human health - pesticides		
5a. Acute effects	0.05	0.08
5b. Chronic effects	+	+
6. Damage to human health - nitrate		
7. Damage to human health: microorganisms and other disease agents		
7a. Bacterial and viral outbreaks in food	9	14
7b. Antibiotic resistance	+	+
7c. BSEe and nvCJD	32	49
Total	**125**	**189**

*Based on Eurostat data (Environment and Energy/Land Use) on total agricultural land in the United Kingdom in 1995: 18.75 million hectare.
Source: Our adaptation of Pretty et al. (2000).

Table 10. Summary of average global value of annual ecosystem services

Summary of average global value of annual ecosystem services*			
Land Use		(1997 $ per hectare per year)	(2007 € per hectare per year)
Marine		577	616
	Open Ocean	252	269
	Costal	4052	4326
	Estuaries	22832	24378
	Sea Grass/Algae Beds	19004	20291
	Coral Reefs	6075	6486
	Shelf	1610	1719
Terrestrial		804	858
	Forests	969	1035
	Tropical	2007	2143
	Temperate/Boreal	302	322
	Grass/Rangelands	232	248
	Wetlands	14785	15786
	Tidal Marsh/Mangroves	9990	10666
	Swamps/Floodplains	19580	20906
	Lake/Rivers	8498	9073
	Cropland**	**92**	**98**

* Ecosystem services evaluated are: Gas, Climate, Disturbance and Water Regulation, Water Supply, Erosion Control, Soil Formation, Nutrient Cycling, Waste treatment Pollination, Biological Control, Habitat/Refugia, Food Production, Raw Materials, Genetic Resources, Recreation, Cultural Heritage.
** Cropland values include only benefits from Pollination, Biological Control and Food Production.
Source: our adaptation of Costanza et al. (2007) table 2.

Table 11. Groundwater contamination and property values: groundwater contamination

Location	Country	Contaminant	Property Type	Number of Homes h Acres a	Clean up Cost ($ million)	Effect on property price (% decrease)
Barton	Wisconsin, US	VOCs	Residential	41 h	0.5	None
Bear Creek	Wisconsin, US	Alachlor and Atrazine	Residential	3 h	1	None
De pere	Wisconsin, US	VOCs	Residential	18 h	NA	None
Mosinee (Pesticides)	Wisconsin, US	VOCs	Residential	15 h	NA	None
Mosinee (Wood preservative)	Wisconsin, US	Aldicarb	Residential	40 h	NA	None
Stettin	Wisconsin, US	VOCs	Residential	700 h	4.5	None
Wausau	Wisconsin, US	Trichloropenta	Residential	NA	4	None
Herrs's island	Pittsburgh, PA,US	PCBs	Industrial and Commercial	44 a	2.7	27-37
Jones and Laughlin	Pittsburgh, PA,US	Iron-Cyanide	Industrial and Commercial	14 a	NA	NA
Public Safety Building	Pittsburgh, US	TPH	Industrial and Commercial	3.8 a	3	30-40
Commerce Center	Santa Fe Springs, CA, US	Petrochemicals	Industrial and Commercial	75	3	10-20
Kroeger Building	Milwaukee, WI, US	Chromium and Cyanide	Industrial and Commercial	60,000 sqf	NA	50
Badger Boiler & Burner	Milwaukee, WI, US	Methylene Chloride	Industrial and Commercial	NA	NA	NA

Source: Page (1993)

Table 12. Per acre impacts of alternative land uses on selected watershed indicators

Land Use	Estimated impact % (X 10^{-04})					
	Conventional Water Quality (model a)	(model b)	Toxic Water Quality (model a)	(model b)	Species at risk (model a)	(model b)
Urban land	1.3180***		0.8600		0.0482**	
Transportation land	3.2726	13.0459**	54.1381***	34.4464**	0.9177	1.0633
Cultivated Cropland	1.3403***		-0.4915		0.0281	
Pastureland	1.1728***		-2.1445***		-0.0018	
Mining land			8.6116*	9.3041*	0.1321	O.t88t

* = Significant at Ihe 10% level; ** = significani at the 5% level; *** = significant al Ihe 1% level.
Source: Hascic and Wu (2006)

Table 13. Willingness to pay for water quality improvements:

Citation for study	No of observations in metadata	State	Water-body type	Species affected	Methodology	Adjusted raw WTP values (A)
Aiken (1985)	1	CO	All freshwater	Game fish	Contingent valuation (CVM) - multiple methods (B)	$167.98
Anderson and Edwards (1986)	1	RI	Salt pond/marshes marshes	Unspecified	Contingent valuation (CVM) - open ended	$157.14
Azevedo et al (2001)	5	IA	Lake	Game fish	CVM - discrete choice	$17.76–118.68
Bockstael et al (1989)	2	MD	Estuary	Unspecified	CVM - discrete choice	$65.80–209.51
Cameron and Huppert (1989)	1	CA	River/stream	Game fish	CVM - discrete choice	$43.07
Carson et al (1994)	2	CA	Estuary	Game fish; multiple categories	CVM - discrete choice	$35.83–67.47
Clonts and Malone (1990)	3	AL	River/stream	Unspecified	CVM - iterative bidding	$68.10–110.85
Croke et al	9	IL	River/stre	All recreational	CVM - iterative	$53.31–

(1987)			am	rish;none	bidding	81.46
Cronin (1982)	4	DC	River/stream	All recreational fish	CVM - open ended	$61.85–212.73
Desvousges et al (1983)	2	PA	River/stream	Unspecified	CVM - discrete choice	$111.41–220.24
De Zoysa (1995)	2	OH	Lake; river and lake	Multiple categories	CVM - discrete choice	$35.88–61.02
Farber and Griner (2000)	3	PA	River/stream	All recreational fish	CVM - discrete choice	$44.22–105.58
Hayes et al (1992)	2	RI	Estuary	Shellfish, none	CVM - discrete choice	$339.72–351.47
Herriges and Shogren (1996)	2	IA	Lake	All recreational fish	CVM - discrete choice	$53.66–180.35
Huang et al (1997)	2	NC	Estuary	Multiple categories	CVM - discrete choice; revealed and stated preference	$221.75–228.07
Kaoru (1993)	1	MA	Salt pond/marshes	Shellfish	CVM - open ended	$190.10
Lant and Roberts (1990)	3	IA/IL	River/stream	Game fish; all recreational fish	CVM - discrete choice	$107.86–134.18
Loomis (1996)	1	WA	River/stream	Game fish	CVM - discrete choice	$80.93
Lyke (1993)	2	WI	Lake	Game fish	CVM - discrete choice	$51.96–84.99
Magat et al (2000)	2	CO/NC	All freshwater	All aquatic species	CVM - iterative bidding	$114.49–376.61
Matthews et al (1999)	2	MN	River/stream	All aquatic species	CVM - discrete choice	$15.77–22.01
Mitchell and Carson (1981)	1	National	All freshwater	All aquatic species	CVM - discrete choice	$242.34
Olsen et al (1991)	3	Pacific NW	River/stream	Game fish	CVM - open ended	$34.48–107.59
Roberts and Leitch (1997)	1	MN/SD	Lake	Multiple categories	CVM - discrete choice	$7.26
Rowe et al (1985)	1	CO	River/stream	Game fish	CVM - open ended	$117.04
Sanders et al (1990)	4	CO	River/stream	Unspecified	CVM - open ended	$70.44–171.59
Schulze et al (1995)	2	MT	River and lake	Multiple categories	CVM - discrete choice	$15.08–21.16
Stumborg et al (2001)	2	WI	Lake	Multiple categories	CVM - discrete choice	$57.90–88.38
Sutherland and Walsh (1985)	1	MT	River and lake	Unspecified	CVM - open ended	$126.98
Welle (1986)	6	MN	All freshwater	Multiple categories; game fish	Multiple methods	$95.30–207.32
Wey (1990)	2	RI	Salt	Shellfish	Multiple methods	$55.61–

			pond/marshes			200.50
Whitehead and Groothuis (1992)	3	NC	River/stream	All recreational fish	CVM - open ended	\$27.74–46.23
Whitehead et al (1995)	2	NC	Estuary	Multiple categories	CVM - iterative bidding	\$68.08–97.91
Whittington et al (1994)	1	TX	Estuary	All aquatic species	CVM - discrete choice	\$169.32

Source: Johnston et al. (2005)

Table 14. Air emissions in European countries in the year 2000

Year = 2000 Country	Emission of greenhouse gases (Global warming potential, CO2 equivalent) Tons	Sum of air emissions of primary PM10 and the weighted missions of PM10 precursors (in PM10 equivalents) Tons	Emission of acidifying pollutants (Acid equivalent) Tons	Emission of tropospheric ozone precursors (Tropospheric ozone formation potential (TOFP) equivalent) Tons
Austria	81103767	282683.62	9330.73	512788.19
Belgium	147540214	504406.36	17606.46	776066.91
Bulgaria	66942563	828650.66	38022.41	599050.18
Czech Republic	149025801	583721.6	19581.2	697551.08
Germany	68198830	288005.95	11613.93	449250.49
Denmark	1019766023	2578448.26	96403.9	4300167.96
Estonia	19736069	134547.26	4311.77	104573.17
Spain	384429936	2560639.75	102571.76	3258265
France	559701275	2610172.56	96116.01	4484751.82
Greece	131752458	666789.2	26821.82	847433.44
Croatia	25245169	120765.8	6147	215025.15
Hungary	79065288	518077.8	23389	474074.75
Ireland	69118432	279708.58	14429.97	283870.16
Italy	553764069	2083381.13	79543.29	3778742.59
Lithuania	18711982	81839	3861.84	151909.54
Luxembourg (Grand-Duché)	9544790	25043.89	892.29	41319.13
Latvia	10049149	57600.82	1828.99	140263.16
Netherlands	214432859	526874.63	19769.97	806906.72
Poland	405085615	2037361	84377.32	2028709.27
Portugal	82255206	575734.85	20207.71	734216.3
Romania	138583488	981933.41	41139.44	1023864.85
Slovenia	18706301	127368.12	5552.02	135123.22
Slovakia	48290342	223764	8111.16	249371.56
United Kingdom	673961261	2662919.8	99368.72	4164738.49

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Table 15. Air quality: impact pathway table

Impact Category	Pollutant	Effects
Human Health (mortality)	PM_{10}, SO_2,NOx, O_3	Reduction in life expectancy
	Benzene, Benzo-[a]-pyrene, 3-butadiene, Diesel particles	Cancers
Human Health (morbidity)	PM_{10}, O_3, SO_2	Respiratory hospital admissions
	PM_{10}, O_3	Restricted activity days
	PM_{10}, CO	Congestive heart failure
	Benzene, Benzo-[a]-pyrene,3-butadiene, Diesel particles	Cancer risk (non-fatal)
	PM_{10}	Cerebro-vascular hospital admissions
		Cases of chronic bronchitis
		Cases of chronic cough in children
		Cough in asthmatics
		Lower respiratory symptoms
	O_3	Asthma attacks
		Symptom days
Building Material	SO_2 and Acid deposition	Ageing of galvanised steel, limestone, mortar, sand-stone, paint, rendering, and zinc for utilitarian buildings
	Combustion particles	Soiling of buildings
Crops	NOx, SO_2	Yield change for wheat, barley, rye, oats, potato, sugar beet
	O_3	Yield change for wheat, barley, rye, oats, potato, rice, tobacco, sunflower seed
	Acid deposition	Increased need for liming
Global Warming	CO_2, CH_4, N_2O, N, S	World-wide effects on mortality, morbidity, coastal impacts, agriculture, energy demand, and economic impacts due to temperature change and sea level rise

Table 16. Hedonic price of urban amenities in Paris

Variable name	Hedonic price (2006 Euros)	Elasticity (%)
MWTP for reducing the fraction of poorly performing peers by 1%	255	0.0659
MWTP for reducing class size by 1 pupil	854	0.2212
MWTP to reduce the time necessary to reach Paris city centre by 1 minute per day commute by public transportation	345	0.1631
MWTP to reduce the time necessary to reach Paris city centre by 1 minute per day commute by car	276	0.2744
MWTP for a 1 kilometer reduction of the distance to the nearest freeway entrance	857	0.0302
MWTP for a 1 kilometer reduction in the density of the highway network	1881	0.0050
MWTP for leaving an extra kilometre distance from the Roissy Airport	275	0.0756
MWTP for 1 extra meter scenic roads	168	0.0001
MWTP for 1 extra meter elevation of the house	225	0.0002
MWTP for a 1% increase in the fraction of the city land open to recreational activities (not occupied by agriculture, roads or buildings)	98	0.0091
MWTP to add one extra monument	482	0.0010
MWTP to add one extra shop in 10000 inhabitants	59	0.0404
MWTP to add one extra auditorium	4105	0.0121
MWTP to add one extra playground	733	0.0063
MWTP to avoid a 1% increase in dwelling tax	718	0.1119
MWTP to avoid a 1% increase in property tax	773	0.0967
MWTP for a 1% reduction in the poverty rate	670	0.2322

Source: Gravel et al. (2006): house average price is 112380.40 (64795.62 standard deviation).

Table 17. The Impact of Crime Rates on House Values

Reference	Variable Definition	Elasticity (%)
Clark and Herrin (2000)	murder rate per 1000 people	0.000014
Acharya and Bennett (2001)	crime rate per 1000 people	0.0000004
Saphores and Benitez (2005)	crime rate per 1000 people	0.0000004
Brasington and Haurin (2006)	crime rate per 1000 people	0.00000005
Brasington and Haurin (2006)	crime rate per 1000 people	0.00000003

Table 18. Water values by use 2007 Euro per m^{3*}

Water Use	Average	Median	Minimum	Maximum	Number of Values
Waste Disposal	0.0025	0.0008	0.0000	0.0099	23
Recreation/Fish and Wildlife Habitat	0.0397	0.0041	0.0000	2.1868	211
Navigation	0.1208	0.0083	0.0000	0.3998	7
Hydropower	0.0207	0.0174	0.0008	0.0935	57
Irrigation	0.0621	0.0331	0.0000	1.0164	177
Industrial Processing	0.2334	0.1093	0.0232	0.6638	7
Thermoelectric Power	0.0281	0.0240	0.0074	0.0521	6
Domestic	0.1606	0.0803	0.0306	0.4743	6

* $ 1994 per acre-foot were converted into 2007 € per m3 using the following conversion factor: 0.000827696 = 0.000810713 *(106.2/75.9)/1.3705

Table 19. Example of transport costs

Market-priced costs	Non-market costs	Transfers
Private vehicle costs	Travel Time costs	Tolls
Public transportation system costs	Environmental costs Air pollution Water pollution Noise Solid/Chemical waste Oil extraction	Fares
Highway facility costs	Pain and Suffering components of accident costs	Fuel
Economic components of accident costs		Other Taxes

**Source: DeCorla-Souza et al. (1997)

Table 20. Output elasticities of Highway and Other Infrastructure investments

Study	Country	Infrastructure measure	Elasticity range (GDP)
Lakshmanan and Anderson (2004)	United States Japan	Public Infrastructure Capital* Highway capital Transportation and Telecommunication	0.05 – 0.39 0.04 – 0.15 0.35 – 0.42
Pereira (2001) Data: early 1960 – late 1980 Long run elasticities	Australia Belgium Canada Finland France Germany Greece Japan Spain Sweden UK US	Public Infrastructure Capital	0.0167 – 0.0176 0.0637 – 0.0787 0.0168 – 0.0310 0.0513 – 0.0721 0.0775 – 0.1135 0.1518 – 0.2083 0.0340 – 0.0407 0.1717 – 0.2525 0.0271 – 0.0439 0.2061 – 0.2329 0.1062 – 0.1430 0.2091 – 0.2573
Demetriades and Mamuneas (2000) Data: 1972 – 1991 Long run elasticities	Australia Belgium Canada Finland France Germany Italy Japan Norway Sweden UK US	Public Infrastructure Capital	1.5047 – 2.0613 1.1831 – 2.0769 0.7806 – 1.0394 0.7473 – 1.5627 0.5859 – 0.7741 0.6876 – 0.8484 0.4782 – 0.6898 0.2560 – 0.7420 1.0811 – 2.8569 0.9838 – 1.4502 0.3070 – 0.4090 1.0182 – 1.0418
			Elasticity range (Industry earnings)
Chandra and Thompson (2000)	US	Location of a new Highway Farming Retail Trade Government Manufacturing	 -0.30 - -0.10 -0.06 - -0.03 -0.06 - -0.03 +0.02 - +0.10

* Public capital includes transportation and communication infrastructure and structures in electricity, gas and water. Military capital stocks are not included.

Table 21. Money values of reduced transportation time

Study	Value category	Money Values % wage/hour	Standard Deviation	Location
Forslund and Johansson, 1995	Commuting Shopping Leisure Business Truck driver Cargo Personal car Truck including Cargo Travellers by bus	0,300[4] 0,252 0,204 1,983 1,356 0,291 0,822 1,917 0,318		Sweden (average over 53 investment projects)
Zamparini and Reggiani (2007)	Commuting Business Other	0,5547 1,4560 0,5950	0,3881 0,8008 0,3931	Number of studies 41 26 23
Zamparini and Reggiani (2007)	North-Europe Centre-South Europe North-America Oceania	82,92 101,18 67,72 51,86	63,63 84,92 47,08 45,27	Number of studies 40 25 18 7
Zamparini and Reggiani (2007)	Airplane Bus Car Train	145,75 56,81 82,44 77,47	81,61 48,49 69,03 43,86	Number of studies 4 8 70 8
Small (1997)	Time Schedule delay	0,40[5] 0,50[6]		
Steimetz and Brownstone (2005)	*Overall* *Car Work Trips* Income>$80K Income<$80K Full-time workers Part-time workers *Car Non-work trips* Income>$80K Income<$80K Full-time workers Part-time workers	29,68 64,90 21,52 44,12 15,65 14,35 9,60 10,83 7,25	17,39[7] 39,69 15,87 25,77 13,76 12,26 8,14 8,72 6,51	Bootstrap median VTTS in '$ per hour (California)

[4] Obtained multiplying values in table 2 and 3 in Forslund and Johansson (1995) by 0,3 (The time savings with regard to commuting to the work are valued as equivalent to 30% of the relevant wage level, p.169) and dividing by 100.

[5] Obtained dividing the value of time savings ($4,80 per hour) by the wage rate ($11,58) adjusted by the ratio of metropolitan wages to average US wages (1,047) reported on p. 676.

[6] Obtained dividing the value of schedule delay ($6,06 per hour) by the wage rate ($11,58) adjusted by the ratio of metropolitan wages to average US wages (1,047) reported on p. 676.

[7] In this cell we report interquartile ranges instead of standard deviations.

Gravel et al. (2006	Commuting	3€/ hour		Hedonic study (Paris)

Table 22. Value of travel time savings (VTTS) Database of passengers´ transport studies

Num-ber	Region	Country	Author(s)	VTTS as % of wage rate	Trip purpose	Mode	Per capita GDP, thousands of USA Dollars
1	North-Europe	Sweden	EURET (1994)	157,5	Employer´s business	Car	26,49
2	North-Europe	Sweden	Algers et al. (1996) National VTTS study	126,0	Employer´s business	Car	31,91
3	North-Europe	Sweden	Algers et al. (1996) National VTTS study	43,5	Commuting	Car	31,91
4	North-Europe	Sweden	Algers et al. (1996) National VTTS study	21,0	Others	Car	31,91
5	North-Europe	Sweden	Algers et al. (1996) National VTTS study	106,0	Employer´s business	Air	31,91
6	North-Europe	Sweden	Algers et al. (1996) National VTTS study	66,0	Commuting	Air	31,91
7	North-Europe	Sweden	Algers et al. (1996) National VTTS study	99,0	Employer´s business	Train	31,91
8	North-Europe	Sweden	Algers et al. (1996) National VTTS study	56,8	Commuting	Train	31,91
9	North-Europe	Sweden	Algers et al. (1996) National VTTS study	38,5	Commuting	Bus	31,91
10	North-Europe	Sweden	Algers et al. (1996) National VTTS study	21,0	Others	Bus	31,91
11	North-Europe	Norway	Hansen (1970)	38,0	Commuting	Car	11,8
12	North-Europe	Norway	Ramjerdi et al. (1997)	151,0	Employer´s business	Car	33,28
13	North-Europe	Norway	Ramjerdi et al. (1997)	82,0	Commuting	Car	33,28

14	North-Europe	Norway	Ramjerdi et al. (1997)	106,0	Employer´s business	Rail	33,28
15	North-Europe	Norway	Ramjerdi et al. (1997)	49,0	Commuting	Rail	33,28
16	North-Europe	Norway	Ramjerdi et al. (1997)	86,5	Employer´s business	Bus	33,28
17	North-Europe	Norway	Ramjerdi et al. (1997)	36,5	Commuting	Bus	33,28
18	North-Europe	Norway	Ramjerdi et al. (1997)	255,0	Employer´s business	Air	33,28
19	North-Europe	Norway	Ramjerdi et al. (1997)	156,0	Commuting	Air	33,28
20	North-Europe	Denmark	EURET (1994)	71,5	Employer´s business	Car	29,66
21	North-Europe	Finland	EURET (1994)	327,0	Employer´s business	Car	20,47
22	North-Europe	Ireland	EURET (1994)	148,0	Employer´s business	Car	15,73
23	North-Europe	UK	Dawson and Smith (1959)	86,0	Interurban	Car	16,13
24	North-Europe	UK	Beesley (1965)	41,5	Commuting	Car	19,14
25	North-Europe	UK	Quarmby (1967)	22,5	Commuting	Car	19,72
26	North-Europe	UK	Stopher (1968)	26,5	Commuting	Car	17,52
27	North-Europe	UK	Lee and Dalvi (1969)	30,0	Commuting	Bus	17,8
28	North-Europe	UK	Dalvi and Lee (1971)	40,0	Commuting	Car	18,92
29	North-Europe	UK	Wabe (1971)	43,0	Commuting	Rail	18,92
30	North-Europe	UK	Ghosh et al. (1975)	73,0	Interurban	Car	18,61
31	North-Europe	UK	MVA et al. (1987)-1985 VTTS study	127,0	Employer´s business	Car	12,82
32	North-Europe	UK	MVA et al. (1987)-1985 VTTS study	95,5	Commuting	Car	12,82
33	North-Europe	UK	MVA et al. (1987)-1985 VTTS study	88,0	Others	Car	12,82
34	North-Europe	UK	Bates (1987) (Route choice)	65,0	Interurban	Car	17,73
35	North-Europe	UK	Bates (1987) (Route choice)	43,0	Commuting	Car	17,73
36	North-Europe	UK	Polak et al. (1993)	34,0	Commuting	Car	17,39
37	North-Europe	UK	Polak et al. (1993)	22,0	Others	Car	17,39
38	North-Europe	UK	Gunn et al. (1996)-related to 1994	108,0	Employer´s business	Car	18,7
39	North-Europe	UK	Gunn et al. (1996)-related to 1994	35,0	Commuting	Car	18,7

40	North-Europe	UK	EURET (1994)	95,0	Employer´s business	Car	18,7
41	Center-South-Europe	The Nether-lands	Atkins (1994)	23,0	Employer´s business	Car	23,12
42	Center-South-Europe	The Nether-lands	Atkins (1994)	45,0	Commuting	Car	23,12
43	Center-South-Europe	The Nether-lands	Atkins (1994)	27,0	Others	Car	23,12
44	Center-South-Europe	The Nether-lands	Wardman and Mackie (1997)	31,0	Commuting	Car	23,37
45	Center-South-Europe	The Nether-lands	Wardman and Mackie (1997)	33,0	Others	Car	23,37
46	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	171,0	Employer´s business	Car	18,16
47	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	51,5	Commuting	Car	18,16
48	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	41,0	Others	Car	18,16
49	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	167,0	Employer´s business	Train	18,16
50	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	59,0	Commuting	Train	18,16
51	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	40,0	Others	Train	18,16
52	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	166,0	Employer´s business	Bus	18,16
53	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	48,0	Commuting	Bus	18,16
54	Center-South-Europe	The Nether-lands	Data of 1988 in HCG (1998)	28,0	Others	Bus	18,16
55	Center-South-Europe	The Nether-lands	EURET (1994)	150,0	Employer´s business	Car	23,12
56	Center-South-Europe	Germany	PLANCO and Heusch-Boesefeldt (1991)	141,0	Employer´s business	Car	25,22
57	Center-South-Europe	Germany	PLANCO and Heusch-Boesefeldt (1991)	57,0	Commuting	Car	25,22

58	Center-South-Europe	Germany	EURET (1994)	129,0	Employer´s business	Car	26,29
59	Center-South-Europe	Germany	BMW (1994)	342,0	Employer´s business	Car	26,29
60	Center-South-Europe	Germany	BMW (1994)	167,0	Commuting	Car	26,29
61	Center-South-Europe	Germany	BMW (1994)	71,0	Others	Car	26,29
62	Center-South-Europe	France	EURET (1994)	84,0	Employer´s business	Car	23,71
63	Center-South-Europe	Austria	Transprice (1997)	13,0	Employer´s business	Car	24,83
64	Center-South-Europe	Italy	EURET (1994)	151,0	Employer´s business	Car	18,83
65	Center-South-Europe	Portugal	EURET (1994)	285,0	Employer´s business	Car	9,34
66	North-America	USA	Mohring (1961)	32,5	Commuting	Car	12,77
67	North-America	USA	Claffey (1961)	65,0	Interurban	Car	12,86
68	North-America	USA	Becker (1965)	42,0	Commuting	Car	15,16
69	North-America	USA	Lisco (1967)	45,0	Commuting	Car	16,2
70	North-America	USA	Thomas (1967)	72,0	Commuting	Car	16,2
71	North-America	USA	Oort (1969)	33,0	Commuting	Car	17,16
72	North-America	USA	Thomas and Thompson (1970)	62,5	Interurban	Car	17,03
73	North-America	USA	Talvittie (1972)	13,0	Commuting	Car	18,21
74	North-America	USA	McFadden and Reid (1975)	28,0	Commuting	Car	18,55
75	North-America	USA	McDonald (1975)	61,5	Commuting	Car	18,55
76	North-America	USA	Guttman (1975)	63,0	Leisure	Car	18,55

77	North-America	USA	Guttman (1975)	145,0	Commuting	Car	18,55
78	North-America	USA	Nelson (1977)	32,5	Commuting	Car	20,1
79	North-America	USA	Chui and McFarland (1985)	25,0	Interurban	Car	23,48
80	North-America	USA	Deacon and Sonstelie (1985)	82,0	Interurban	Car	23,48
81	North-America	USA	Chui and McFarland (1985)	82,0	Interurban	Car	24,62
82	North-America	Canada	Cole Sherman (1990)	170,0	Commuting	Car	23,61
83	North-America	Canada	Cole Sherman (1990)	165,0	Leisure	Car	23,61
84	Oceania	Australia	Hensher (1977)	39,0	Commuting	Car	5,56
85	Oceania	Australia	Hensher (1977)	35,0	Leisure	Car	5,56
86	Oceania	Australia	Hensher and McLeod (1977)	20,0	Leisure	Car	5,56
87	Oceania	Australia	Hensher and Louviere (1982), cited in Hensher (1989)	46,0	Commuting	Car	5,42
88	Oceania	Australia	Hensher and Truong (1985)	153,0	Leisure	Car	4,11
89	Oceania	Australia	Hensher (1989)	36,0	Commuting	Car	5,08
90	Oceania	Australia	Hensher and Beesley (1990)	34,0	Commuting	Car	4,97

Source: Zamparini and Reggiani (2007)

Table 23 Value of railway access

Study	City,Country	House price Elasticity Value % per km	Year of Data Collection	Research methodolgy
Gibbons and Machin (2005)	London, UK Holborn Bromley London	 2,1 1,5 8,9	1997-2001	Quasi-experimental innovation model Cross sectional regression

Table 24. Transport Demand Elasticities for Public Transport in Four European Countries

Study	Country	Year of Data Collection	Level of aggregation	Indicator of transport demand	Geographical Coverage	Elasticity Value
Helsinki	Finland	1988	Bus, tram, metro, train	Trips	Urban	-0,48
Helsinki	Finland	1995	Bus, tram, metro, train	Trips	Urban	-0,56
Sullström (1995)	Finland	1966-90	Bus, tram, metro, train	Person-Km	Urban, interurban	-0,75
Netherlands	Netherlands	1984-85	Bus, tram, metro	Trips	Urban, semi-urban	-0,35 /-0,40
BGC (1988)	Netherlands	1980-86	Bus, tram, metro	Trips	Urban, semi-urban	-0,35 / -0,40
Roodenburg (1983)	Netherlands	1950-80	Bus, tram, metro	Person-Km	Urban, semi-urban	-0,51
Fase (1986)	Netherlands	1965-81	Bus, tram, metro	Person-Km	Urban	-0,53 / -0,80
Gunn (1987)	Netherlands	1986	Train	Person-Km	Semi-Urban	-0,77
Oum (1992)	Netherlands	1977-91	Bus, tram, metro	Person-Km	Urban, semi-urban	-0,74
Oslo	Norway	1990-91	Bus, tram, metro, train	Trips	Urban	-0,40
Norway	Norway	1991-92	Bus	Trips	Interurban	-0,63
UK	UK	1991	Bus, tram, metro, train	Trips	Urban, interurban	-0,15

Source: Nijkamp and Pepping (1998)

Table 25. Unit Costs of Paved Roads in 1985 $ per km.

Region	Country	Unit Costs of Construction
European Union	Austria	506012
	Belgium	402887
	Denmark	400378
	Finland	477889
	France	386139
	West Germany	443177
	Hungary	159311
	Ireland	399348
	Italy	296089
	Luxembourg	402887
	Netherlands	529989
	Norway	438496
	Poland	NA
	Portugal	236770
	Spain	236990
	Sweden	522244
	UK	777133
North America	Canada	500760
	US	627580
Asia	China	NA
	Hong Kong	305218
	India	143306
	Japan	339714
Oceania	Australia	869154

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See part B of this report

References 3.7.1

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