ECONADAPT

The Economics of Adaptation

Funded by the European Union

Determining discount rates: An application of the Equivalency Principle

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Deliverable number	3.1
Work Package Number	3
Submission date	2015/10/01
Type of Activity	RTD
Nature	R = Report
Dissemination level	Public

Document information

Title:	Determining discount rates: an application of the Equivalency Principle
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Date:	2015/10/01
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Work Package Number	WP3
Deliverable number	D3.1B
Filename:	Deliverable 3_1B_201510
Document history:	
Type of Activity	RTD
Nature	R
Dissemination / distribution level	PU
Citation:	
Copyright:	

The ECONADAPT project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 603906.

To find out more about the ECONADAPT project, please visit the web-site: www.econadapt.eu

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1 Introduction

The literature on discounting is vast and complete. Recently While Goulder and Williams III (2012) argued that we should use a single discount rate concept towards two different notions: one being the "social welfare equivalent" to account for social welfare and second one, the "finance equivalent". The authors propose that this helps clarifying whether the discount rate should play a prescriptive or descriptive role. We also argued in favour of dual discounting in Chiabai et al. (2013) defining the so called "Equivalency Principle" based "on the premise that the long term value of a piece of undeveloped land ought to be at least the same as the value of an identical piece of land in the vicinity to which permission has been granted for development". That is that if natural assets are to be preserved for future generations, granting permits should not increase the value of a land exponentially, giving no incentive what so ever to preserve land by re-utilising already used (may be contaminated) land. Since the work done in Chiabai et al. (2013) we have attempted to develop the idea much further with the intuition that several types of equivalency principles should be developed, and most likely that discount rates should differ geographically depending on the attribute to be evaluated and the preferences of society.

But in order to depart from traditional financial debates about discounting that can lead to important differences in the results of cost benefit analysis for projects and policies, and therefore on the decision that will be made, one needs to be able to set some common ground rules.

Discounting is especially relevant in the context of climate change as it requires addressing long term, and often intergenerational, decision-making. Decision-makers will have to determine which mitigation or adaptation policies should be implemented in the short term and which should be delayed based, among other criteria, on their relative costs and benefits. In this context, discounting has become a key element of the analysis (Agrawala and Fankhauser, 2008). In the context of investments for adaptation one could easily imagine situations in which decisions to allocate new land for constructing infrastructures are to be made. For example, to build protections for sea level rise, water irrigation structures or similar.

Since standard discounting pays not much attention to future generations (Groom, 2014), scholars such as Stern (2007)or Weitzman (1998) have advocated for low (even negative) rates for discounting when discussing climate change policies, arguing in terms of ethical grounds. The debate started by Stern (2007) advocating for low rates that would justify acting now to combat climate change through an ambitious climate policy versus Nordhaus (2007), in favour of close to market interest rate discounting, and it is not yet totally settled. Perhaps, as Groom (2014) argues "something resembling a consensus has emerged in the theory of discounting long-term horizons" by agreeing in a rate that should decline with time horizon or maturity of the costs and benefits. And this debate has influenced many policy decisions. But many issues remain to be answered and especially addressed in way that can guide decision making.

In this work package we aimed at further exploring the concept of the Equivalency Principle (EP) showing that geographically differentiated discounting is a practicable rule that could lead investment decision in the context of environment and resource economics. For this purpose we have collected price and "value" information for more than 200 sites from 30 European countries and calculated the rates that according to EP rule should be used. That is, those rates that will make the value of natural land and land with "granted permit to build on" equivalent. The application of this rule ensures that natural attributes of a piece of land, together of the rest of attributes, are well valued in any project appraisal. That is, it allows breaking the vicious-circle of cheap natural land being economically preferred in the new developments rather than very expensive land with "permit to be developed". We have illustrated this and showed that when this rule is applied relatively discount rates can be justified not only on ethical grounds but also on economic grounds. And the methodology is relatively simple and applicable for project appraisal.

This idea has many applications in the context of climate change adaptation when most of the investment decisions have intergenerational implications. In this WP we have applied the EP to the value of land but could be applied for any other assets or natural resources including air quality, water, ecosystems and public health issues.

The document is organised as follows: Section 2 is devoted to analysing the economic rationale behind the discounting practices and explaining how to apply the EP. Section 3 explains how the method has been applied in a number of sites in Europe. Section 4 shows the results while 5 is devoted to conclusions.

2 The Equivalency Principle

Decisions with consequences that occur over the future are known in economics as *intertemporal choices*. From an economic perspective, intertemporal choices have been assessed during the last 80 years using the discounted utility (DU) model, formulated by Samuelson (1937). The DU model is based on the assumption that people make decisions by assessing its (positive or negative) consequences in a similar way to how the market evaluates gains and losses: "exponentially discounting the value of an outcome" depending on how far in time this outcome occurs (Berns et al., 2007: 1). In other words, the model is based on the assumption that society prefers to receive short-term benefits while delaying costs to the future. Thus, the weight given to future welfare decreases with time (Gowdy et al., 2010).

But how much should the value of a future outcome be discounted? Which discount rate should be used? Lower discount rates imply a higher valuation today of a future outcome and, the other way around, higher discount rates entail a lower value for the future. Let us imagine that a region needs to decide if, as a result of climate change, it would be necessary to invest in the construction of a new sea-dyke to protect its coastal zone from storm-surge events, and in case it is considered necessary when this investment should take place. The use of market-based discount rates would lead to a lower present value of future economic impacts related to storm-surge flood events and therefore, the decision to invest might be abandoned or delayed. Conversely, using lower discount rates will provide a higher present value of these future economic costs. In this case, action might need to be taken sooner than in the previous case.

Following the example, a low discount rate involves greater economic sacrifices to the current generation versus future ones, which, according to general economic theory, will be richer. In contrast, a higher discount rate could lead to an underestimation of future impacts (Philibert, 2006). This is why the classical framework for representing intertemporal choices based on discount rates observed in the market has been criticised, especially when assessing global environmental issues such as climate change or biodiversity loss. Several authors have defended the need for a change in the framework of intertemporal choices (Graaff, 1987; Bromley, 1998; Spash, 2002; Gowdy, 2004), but the Stern Report, which proposed a discount rate close to zero, has been a major milestone regarding this issue. A heated debate followed its publication (Groom, 2014), which initially focused on the appropriate discount rate, as seen in Nordhaus (2007), for example. Nevertheless, several leading economists, such as Dasgupta (2007) or Weitzman (2009), have also concluded that the standard traditional framework is inadequate to address environmental problems characterised by irreversibility, uncertainty and long-term horizons (Gowdy et al., 2010). Other authors agree on the need for action on climate change, but consider the Stern Report to be incomplete and its conclusions to be incorrect from an economic perspective (Tol, 2006; Tol and Yohe, 2006).

Nordhaus (2007), in his review of the Stern Report, points out that discounting comprises two concepts that should not be confused. The first concept is the "real interest rate"[1] defined as "the annual percentage increase in the purchasing power of a financial asset" and is calculated as "the nominal or market interest rate on that asset minus the inflation rate[2]"·(Frank and Bernanke, 2007: G-5). These values are, in principle, observable in the market. For instance, the real return of Spanish Treasury securities in June 2014 varied between 1.52% (5 year securities) and 4.52% (30 year securities).

The second concept, often known as "pure rate of social time preference", is related to the economic welfare of households or generations across time. That is, it "refers to the discount

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[1] It is also known as real return, the opportunity cost of capital, or the real return on capital.

[2] The rate of inflation is the annual percentage rate of change in the price level, as measured, for example, by the Consumer Price Index (CPI) (Frank and Bernanke, 2007b: G-5).

in future welfare", not future goods or investments. Discount rates close to zero, as applied in the Stern Report, would mean that present and future generations are considered equally, while a positive discount rate implies a reduction ("discounted") of welfare of future generations compared to the present one (Nordhaus, 2007: 690). Thus, the choice of either alternative is not trivial and may have a decisive influence when assessing the economics of climate policy (Beckerman and Hepburn, 2007). Nordhaus (2007) supports the use of real (market) interest rates close to 6% per year in contrast to the framework proposed by Stern.

An intermediate approach is defended by authors such as Beckerman and Hepburn (2007). These authors opt for alternative methods to reveal social preferences through, for example, stated preference surveys, behavioural surveys, etc. Philibert (2006) suggests the use of declining discount rates when valuing environmental assets that cannot be substituted or reproduced. This viewpoint is also defended by other authors such as Cropper and Laibson (1998), Gollier (2008) and Groom (2014). A similar approach is used by Chichilnisky (1996) who argues that no generation should prevail over the other, so she proposes to use a conventional discounting approach in the near-future and a zero-rate after an inflexion point.

During the last decade, it seems that a non-official consensus has been reached in favour of social discount rates which should decrease in the long term (Groom, 2014). Nevertheless, the debate is not closed yet. In fact, Weitzman (2007) argues that choosing the discount rate is one of the biggest uncertainties related to the economics of climate change.

Following the previous discussion, two main conclusions can be drawn regarding discount rates: on the one hand, that it is a problem with significant ethical implications in relation to intergenerational equity, that is, with the way we value future generations. Prioritising the welfare of the current generation might have a significant impact on that of future generations.

On the other hand, the selected discount rate has a direct influence on the policies under analysis, i.e. the result of a cost-benefit analysis will change significantly depending on the discount rate used. For instance, when applying a positive discount rate to GHG mitigation policies or measures it may turn out that from an economic perspective is best to postpone taking action; however, that might not be the case when using a close to zero discount rate. This is precisely one of the conclusions of the Stern Report, which advocates the need for action, especially in the area of mitigation, to avoid enormous economic impacts (between 5 and 20% of global GDP) in the future.

As stated before, this approach based on the use of low discount rates is not only applicable to climate change, but also to assess other global environmental issues. In a context of land planning, the price of land depends greatly on whether it has been granted permission for development. In this way, two identical pieces of natural land located in the same area may have totally different prices if one of them has the permission to be built upon. This situation generates an anomaly with deep ethical and environmental implications, as it will always be cheaper to artificialize natural land than use or restore existing urban land. Chiabai et al. (2013) argued that both pieces of land should be valued similarly, as the long term value of both pieces of land is at least equivalent; accordingly future generations would probably give them equal utility and economic value. In this context, the authors (op. cit.) developed a rule based on an alternative approach to discounting as a way of making both valuations equivalent. The so-called Equivalency Principle can be applied when two conditions are met:

1. Past decision making by the administrative unit[3] of reference on development versus protection of natural assets has been socially optimal, so that the marginal present value of the preserved land is equal to the marginal present value of the adjacent developed land.
2. Future generations may be affected in the long run by the decision taken on the land under analysis.

For the present analysis it is, therefore, assumed that the allocation of developed and undeveloped land has been socially optimal. It is also reasonable to believe that future generations, especially under climate change, could be affected in the long run by decisions involving the study areas. Accordingly, it is presumed that the case studies presented here meet the two conditions required for the application of the equivalency principle.

3 Methodology

In order for the equivalency principle to be applied, the analysis warrants the need for the collection of two types of datasets; the first to represent the values of natural, or undeveloped land, and the second to illustrate the values of adjacent lands that are either developed or have been allocated, or 'zoned', for a specific type of development purpose i.e. commercial, industrial, residential, by an administrative unit.

Each database is then systemised and analysed, and the economic data compared and contrasted through the application of the equivalency principle. The following subsections provide a detailed description of each step of the analysis.

[3] Chiabai et al. (2012) define administrative unit as "the public administration having the responsibility for land use planning and for granting building permits in a specified area".

3.1 Literature Review

To explore the values of natural or undeveloped land types, an extensive literature review has been conducted using primary and secondary academic/scientific peer-reviewed research. The primary focus of this literature review is to derive estimates, based on select case studies, of the Total Economic Value (TEV) of natural land. The TEV is a concept in cost-benefit analysis that aims to encompass both the use and non-use values derived by people from an environmental good or service, and includes: direct and indirect use values, option values, existence values and bequest values (Figure 1). It is important to note that there is much controversy in the various methodologies employed to measure natural capital, and a one-size-fits all/universal approach is still lacking in this regard. For this reason the TEV is important as it attempts to capture a range of values that can be attributed to a natural resource. That being said, there is much difficulty, particularly in the case of valuing natural land, in defining and accounting for all component values of TEV, with many case studies opting to evaluate one, or a select few, constituents of TEV. For the purposes of this research, it is thus important to explore a range of studies, not only those that estimate TEV, but also those that consider and provide estimates for its component values, i.e. use or non-use values. This is a conscious selection process that will allow for a holistic analysis of a diverse, yet interconnected, range of values with a wider distribution, and which represent a variety of contrasting natural land types that encompass various habitats and ecosystem and human services.

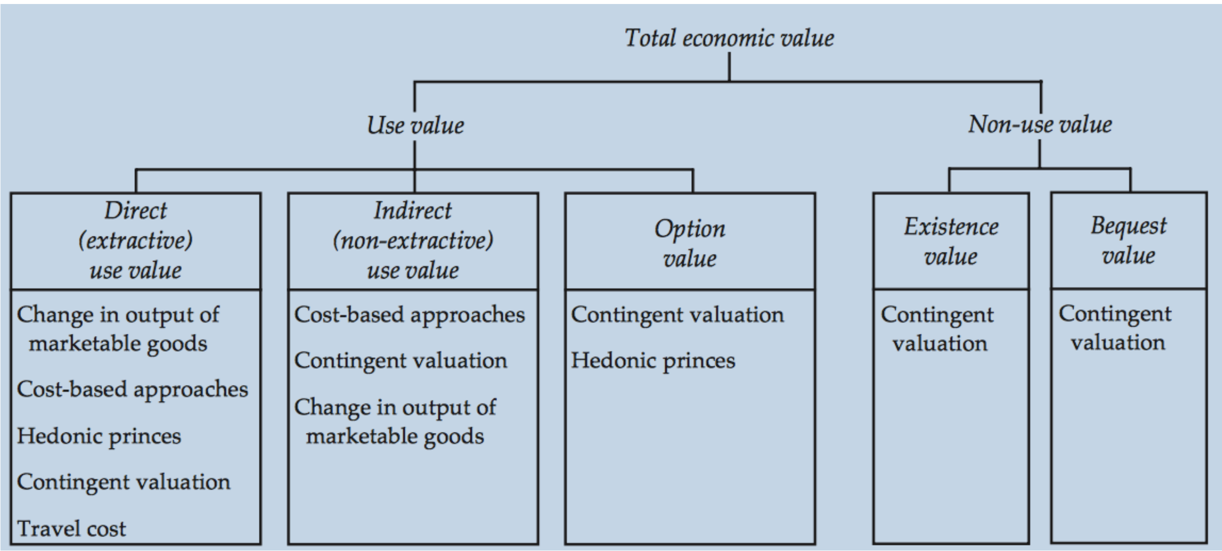

Figure 1. Total Economic Value and Selected Valuation Techniques. Source: World Bank (1998).

Much of the research centred on valuing natural capital is dominated by the use of non-market valuation methods, and can be categorised into direct (stated preference) and indirect (revealed preference) methods. Revealed preference approaches are comprised of methods based on observed behaviour and assumes that people act intrinsically to maximise their welfare. Based on this, revealed preference techniques use actual choices made by consumers (based on market observations), to indirectly place a value on non-market goods. Thus the revealed preference approach is based on the value of consumptive uses, examples of which include the hedonic price and travel-cost method. Alternatively, stated preference approaches elicit direct individual valuations through surveys, hence is based on the value of non-consumptive uses, an example being the Contingent Valuation Method (CVM). Both methods have advantages and disadvantages, for example: direct methods such as CVM are often criticised because of the hypothetical nature of the questions; the fact that individuals do not actually make any behavioural changes means that values are largely hypothetical and are not necessarily indicative of real-life scenarios or actual behavioural choices (Adamowicz et al., 1994).

Whilst recognising the limitations and benefits associated with both direct and indirect methods, it is important in the context of this research to consider both approaches, since failing to do so would limit the scope of the analysis, and would introduce the potential of bias associated with considering just one type of valuation method.

Although priority is given to studies conducted in more recent years, in order to capture a wider distribution of values within Europe, and due to the large volume of research conducted in earlier years, a time-range between 1990 and 2014 is adopted.

3.2 Data on values of natural land

A database on the values of undeveloped land types is constructed based on the available literature centred around case studies from Europe. Each study and value is allocated an ID number, and the information provided by each is systemised according to a number of criteria: source of study; research objective; location (country, region); site name; description of habitat; site status (i.e. protected, not protected); benefits provided by the site (i.e. recreation, biodiversity, tourism); economic value (e.g. TEV, non-use, or use values); valuation method; land area (in hectares); total value per year; value per hectare per year; currency, and; study year.

The final database of undeveloped land values is comprised of 75 studies, and considers over 200 site values from 30 European countries; Austria, Belarus, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia Spain, Sweden, Turkey, Ukraine and the United Kingdom (Figure 2).

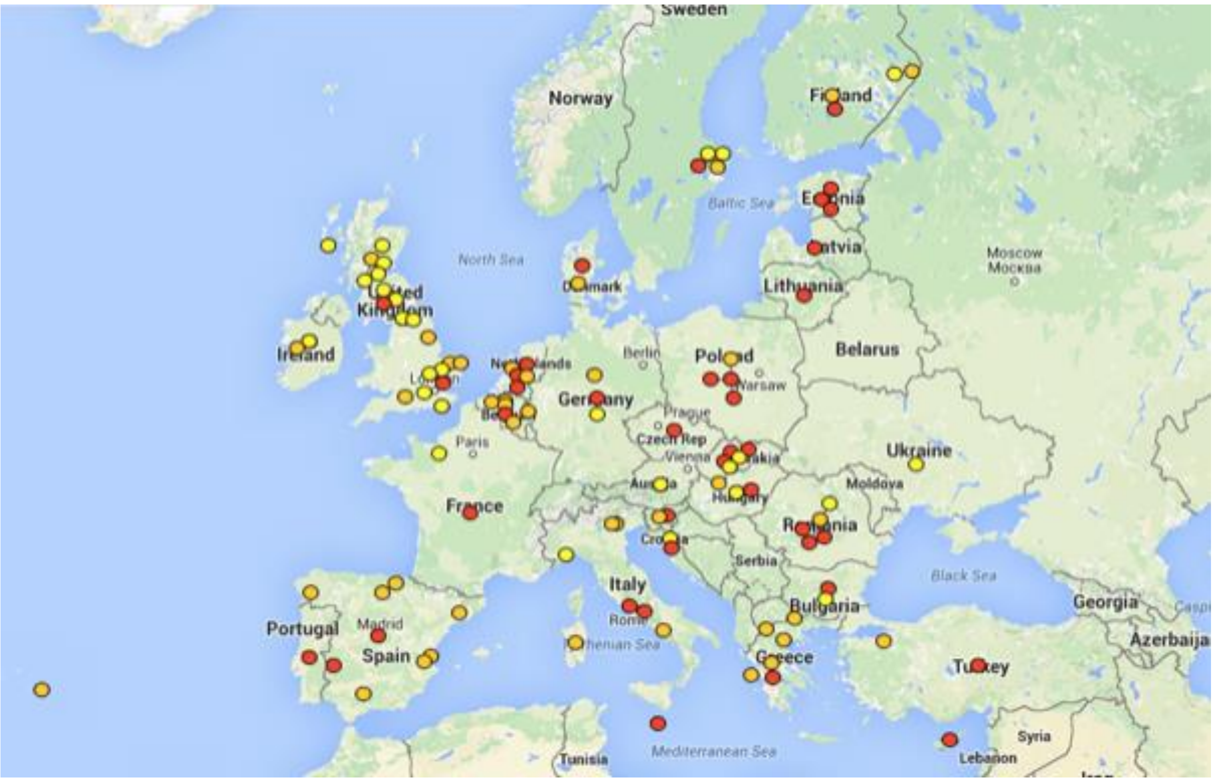

Figure 2. Geographic distribution of study sites in the database. The colour dots represent the time period when the studies were conducted: yellow dots represent studies from 1990 to 1999, orange dots from 2000 to 2009 and red dots show articles from 2010 or newer.

Although the distribution of case studies is widespread, there is an unbalanced availability of data across countries. The three countries providing the largest number of site values are the UK (56), Italy (28) and Spain (16), with the remaining countries offering fewer cases, most of which average between 1 and 5 site values per country. The dispersal of case studies across time is also evident in Figure 2, which broadly illustrates the number of cases researched between 1990 and 1999; 2000 and 2009; and 2010 onwards. The largest number of cases is found between 2000 and 2009, which consists of 43 research studies, containing 112 site values. 20 research papers, containing 68 site values are found between 1990 and 1999, and 12 research papers containing 54 site values are found in 2010 onwards.

In terms of accounting for TEV, it is evident that a strong preference is found in the literature for the use of stated preferences approaches such as the CVM. This method gained popularity during the 1960s, after non-use values, namely option and existence values, were recognised as significant components of the total economic value of environmental resources (Venkatachalam, 2003). This type of direct method is currently the only viable alternative for measuring these values, compared with conventional revealed preferences approaches, such as the travel cost method, which are unable to capture non-use values (Adamowicz et al., 1994). Nearly 70 percent of case studies in this research employ the CVM method to estimate the value of the land, and the majority of all cases (approximately 66 percent) value lands that are protected (Figure 3).

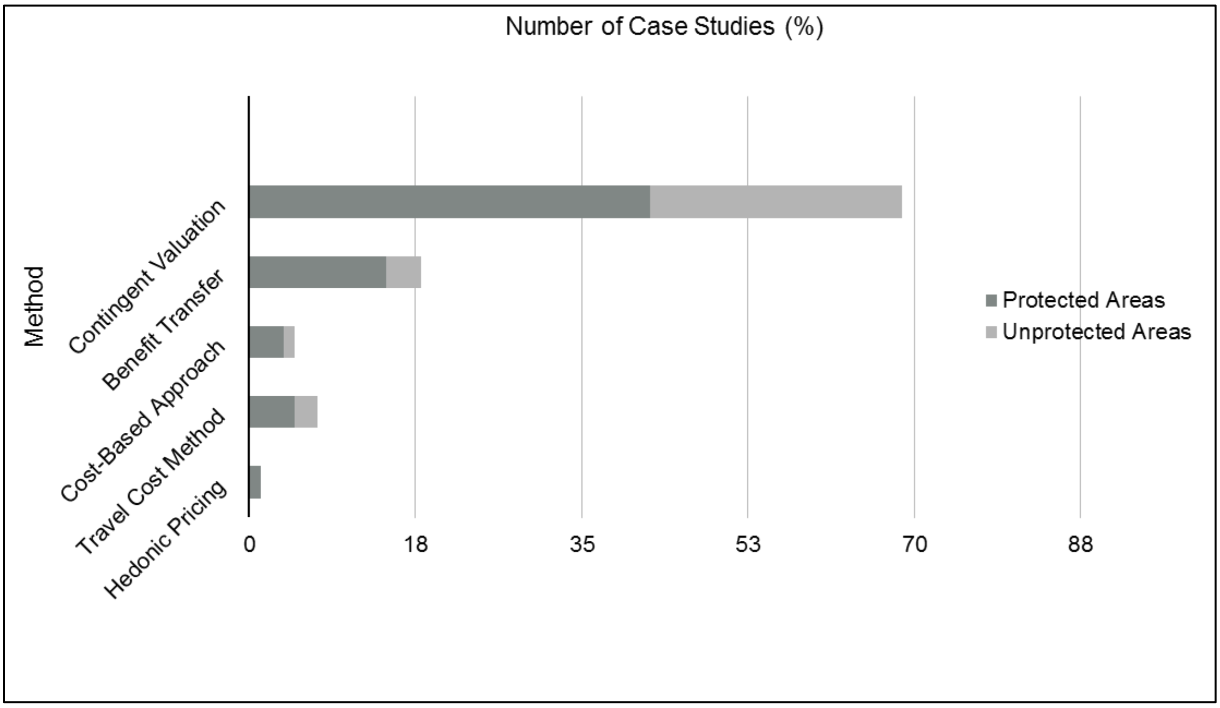

Figure 3. Number of case studies by type of method and site status.

The correlation between using techniques such as CVM and the valuation of protected areas could be linked to the aforementioned idea that protected sites, such as nature reserves, or sites of special scientific interest, tend to encompass a greater range of non-use values, such as ecosystem services and other beneficial environmental attributes. In these cases alternative revealed preference approaches such as the travel cost method or cost-based approaches, are ineffective since they are only able to account for use values, and thus tend to disregard the non-use, i.e. existence and bequest values of a site, leading to an underestimation of total economic value. To reiterate this point; it is clear that the case studies being considered examine a range of habitat types that comprise a spectrum of ecosystem services (Figure 4).

The Millennium Ecosystem Assessment (2005) divides and classifies ecosystem services into four types; provisioning, regulating, cultural, and supporting services. Provisioning services are ecosystem services that describe the material or energy outputs from ecosystems, e.g. food, raw materials, fresh water, and medicinal resources. Regulating services are services that ecosystems provide by acting as regulators, e.g. regulating the quality of air and soil, or by providing flood and disease control. Supporting services, also known as habitat services, are services that ecosystems provide to support the environments necessary for the conservation or survival of plant and animal species, and the maintenance of genetic diversity. Lastly, cultural services can be defined as non-material benefits that contribute to the development and cultural advancement of people, e.g. recreation, tourism, and the aesthetic appreciation and inspiration for culture, art and design.

The case studies under review exhibit a range of habitats and subsequent ecosystem services (Figure 4). Forest and wetland habitats are the most explored in the literature, with over 60 percent of studies valuing these types of environments. Cultural and supporting services are the most prominent land benefits derived from all habitat types, with nearly 70 percent of all studies recognising these services. For cultural services; tourism, recreation, and historical/cultural heritage are found to be amongst the most reoccurring themes, whereas nature/habitat conservation, and biodiversity, are types of benefits mainly attributed to supporting services. Some of the most notable alternative services recognised within the case studies include benefits such as; flood and erosion control, and climate change regulation (regulating services), and fresh water provision and the supply of raw material (provisioning services). A general description of the types of information garnered from the literature, including; types of habitats, site status, land benefits, and methods employed throughout the case studies on natural land are outlined in Table 1.

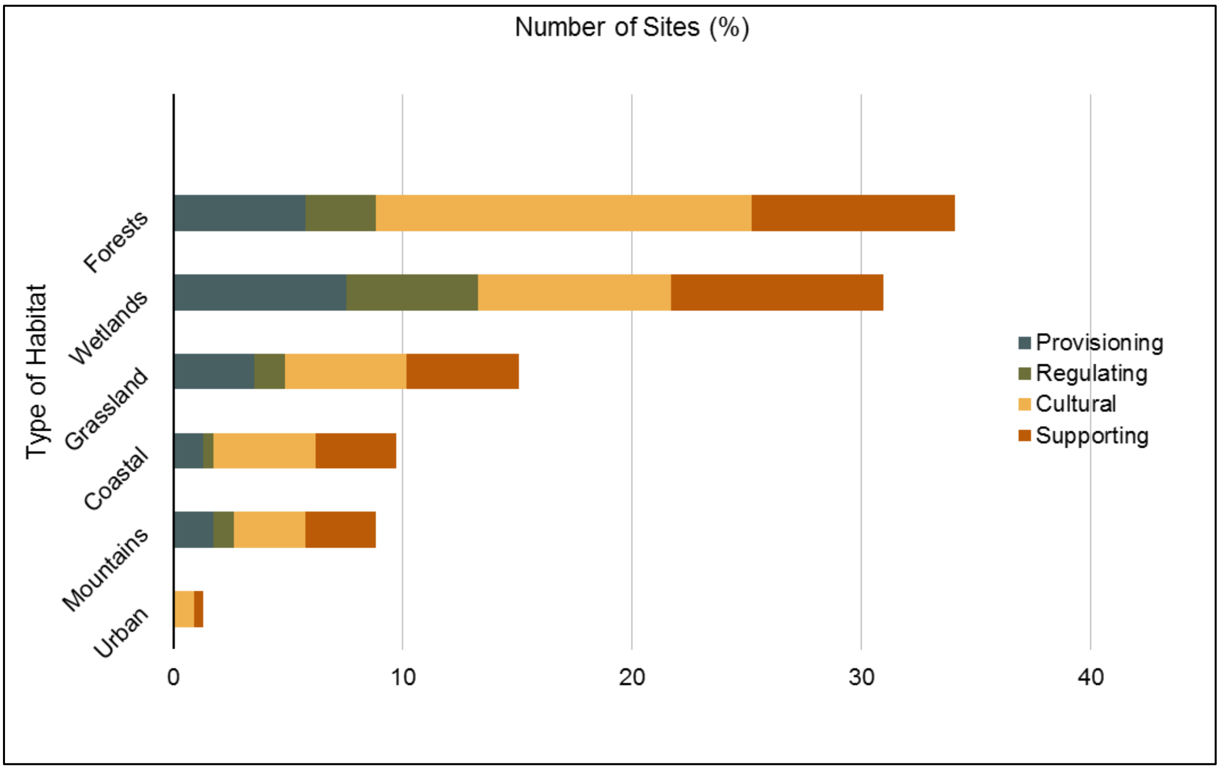

Figure 4. Number of sites by type of habitat and ecosystem services

Table 1. Description of habitats, site status, land benefits and methods employed in case studies.

	Typology	Description
Habitats	Forests	Boreal, coniferous, deciduous, forested swamps, woodland
	Wetlands	Floodplains, rivers, lakes, lagoons, marshes, mud flats, swamps
	Grassland	Farmland, meadows
	Coastal	Shoreline, coastline, dunes
	Mountain areas	Basins, cols, inland hills, valleys
	Green urban areas	Parks, green land, greenbelt
Ecosystem services	Provisioning	Freshwater provision, timber, wood fuel, agriculture, forestry, fisheries
	Regulating	Erosion and flood control, carbon sequestration, water purification and regulation, wind protection
	Cultural Services	Recreation, tourism, cultural and historical heritage, eco-tourism, education
	Supporting Services	Nutrient cycling, habitat and biodiversity creation and conservation
Valuation methods	Contingent Valuation (CVM)	
	Choice Experiments (CE)	
	Benefit/ Value Transfer	
	Cost-based Approaches	
	Travel Cost Method (TCM)	
	Hedonic Pricing	
Status of land	Protected	National Parks, Nature Reserves, Sites of Special Scientific Interest, Sites of Community importance, Ramsar and UNESCO sites, Environmentally Sensitive Areas.
	Unprotected	Urban parks, greenland, agricultural land

In terms of value ranges, i.e. land areas, total values, and values per hectare per year, the data is widespread, demonstrative of the large diversity in variables such as location, differences in land types and benefits, and the variation in methods employed, all of which are important determinants in defining outcome values. For example; the range of land areas considered within the case studies fall between a minimum value of 67 hectares and a maximum value of 5.5 million hectares. Here, the minimum value of 67 hectares is representative of a forest park in Hertfordshire, England[4], and the maximum value of 5.5 million hectares corresponds to a large catchment area of the Guadiana river basin in Spain, which covers a total of eight provinces (Albacete, Badajoz, Caceres, Ciudad Real, Cuenca, Cordoba, Huelva and Toledo)[5]. Despite the large difference in minimum and maximum land areas, it is important to note that the majority of case studies considered sites in the lower range, with over 90 percent of studies valuing sites under 500,000 hectares, 80 percent of which value sites of 100,000 hectares or less. In fact, less than 7 percent of all studies value sites above 1 million hectares. The geographical distribution of sites and their size is represented in Figure 5.

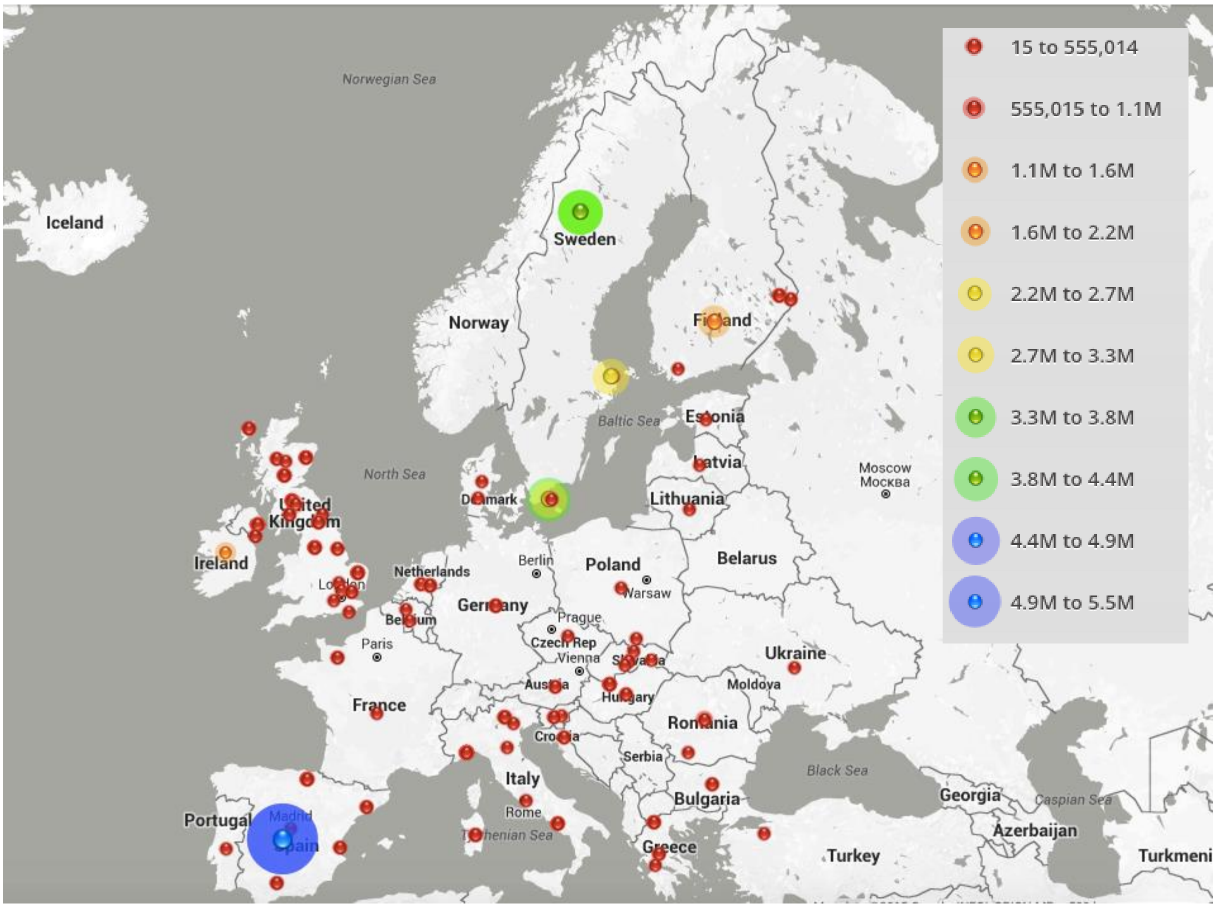

Figure 5. Map showing the distribution of sites by total land size (in hectares).

[4] This value refers to a case study undertaken by Bishop, K. (1992), on assessing the benefits of two urban fringe woodlands in the UK.

[5] The value refers to a study conducted by Ramajo-Hernandez & del Saz-Salazar (2012) on estimating the non-market benefits of water quality improvement for a case study in Spain.

In order for economic estimates to be compared across sites, all values are converted to EUR 2014 prices, by controlling for differences in time and space. Since the studies being examined consider values between 1990 and 2014, differences in time are accounted for first, using the Consumer Price Index (CPI). The CPI controls for changes over time by accounting for inflation in prices. It does so by measuring how the general price level of a market basket of goods and services that a reference population acquires, uses, or pays for consumption, changes through time. Thus, inflation can be measured by calculating the annual percentage change in a CPI. In the context of this research; for each site value the CPI of its relative country in the study year and objective year (in this case 2014) is applied, to derive respective values for 2014. Next, differences in space, i.e. differences in geographic regions, are accounted for by applying Purchasing Power Parity (PPP) conversion factors. The PPP works by equalising the purchasing power of different currencies by removing any differences in price levels between countries. Hence, PPPs illustrate the ratio of prices in national currencies of the same good or service in different countries. Once values are standardised to the year 2014 using the CPI, each site value is converted to the Euro by first applying the PPP of its relative country, which in this case converts prices from national currencies to the US dollar, and next by applying the PPP of the European Union, which converts prices from US dollars to the Euro. Both the CPI and PPP indices are taken from the Organisation of Economic Co-operation and Development (OECD) statistical database[6].

To maintain a consistent approach of currency conversion in line with the OECD guidelines, a final step is taken to account for differences in income levels, as suggested by Pearce (2003). The justification in accounting for income is linked to the hypothesis that environmental quality is regressively distributed across socio-economic groups, whereby low income groups are exposed to greater environmental risks than high income groups. This raises the issue of distributive equity, where demand for environmental quality is dependent on the relative income levels of socio-economic groups (Pearce, 2003). This is an important component to consider particularly in cases where the value of an environmental resource is measured by methods such as CVM. In these cases, individuals are often asked to place a value on the environment based on aspects such as the welfare they gain, and their willingness to pay for conservation efforts or improvements in certain environmental goods or services. When such methods are used to elicit values for the environment, it is fair to assume that individual responses would depend largely on personal factors such as the amount of disposable income a person has, and the proportion of which, he or she is willing to allocate to environmental causes. This will also depend on how much people value the environment relative to other non-environmental goods and services. In fact, it is often debated that environmental quality is considered a 'luxury good', where demand for improvements in the environment is found to

[6] Database on OECD prices and purchasing power parities can be found at: http://stats.oecd.org

be higher for the rich than the poor, and where the extra provision of environmental quality will benefit the rich more than the poor (McFadden, 1994; Pearce, 2003).

For the reasons aforementioned, the income elasticity of ‘demand’ for environmental quality is used to control for regional differences in environmental quality, as well as differences in the income levels of various socio-economic groups living in these areas. This step of the analysis is twofold; first, for each site value the corresponding country GDP (per capita in constant prices) in the study year and objective year (2014) is applied to account for relative income levels. Next, for comparative purposes, both elasticities of 1 and 0.57 are applied to each value to account for the ‘demand’ for environmental quality. An elasticity of 1, also known as constant unit elasticity, is commonly used in economic analysis to describe a supply or demand curve that is perfectly responsive to changes in price, i.e. where the quantity demanded or supplied changes according to the same percentage change in price. Alternatively, Pearce (2003) suggests that the WTP for environmental change is less than unity, and concludes, based on a review of the literature, that an elasticity of between 0.3 and 0.7 should be applied. One of the studies examined by Pearce (2003) suggests an elasticity of 0.57, which is found to be the most applicable in the context of this research, since the author bases his findings on a meta-analysis of landscape studies and landscape change in European countries.

Once prices are standardised, real estimates of total value and value per hectare per year can be compared across studies. The range of total values and values per hectare per year, is widespread, where the total value ranges between €17,280.14 and €4,324,946.21, and value per hectare per year ranges between €2.31 and €260,229.58 (Table 2).

Table 2. Description of data ranges: land area, total value, and value per hectare per year

	Land Area (hectares)	Total Value (EUR 2014)	Flow value per hectare per year (EUR 2014)
Minimum	67	€17,280.14	€2.31
Maximum	5,550,000	€4,324,946,638.21	€260,229.58
Average (mean)	358,560.04	€106,614,365.64	€11,396.49
Average (median)	16,800	€9,784,067.70	€1,321.47

As mentioned previously, the large variation in economic values can be attributed to a number of factors, namely; the type of method employed and values captured, the type of habitat and subsequent land benefits, and land size, which all play a part in determining the total value of a site. For example the minimum value per hectare per year of €2.31 refers to forest site in Liguria, Italy, with a land size of 7,473 hectares. The study uses the travel cost method to value the recreational benefits from forest parks in the Liguria region, and therefore only captures the use-values of the site. Thus, because non-use values are not accounted for in the analysis, the final value of €2.31/ha is likely to be an underestimate of the total economic value[7]. Contrastingly, the maximum value per hectare per year of €260,229.58 refers to an EU Natura 2000 site of 2,400 hectares in the Basque Country, Spain[8]. The value is derived through the CVM, and captures both the use and non-use values of the site, thus is likely to provide a more holistic representation of total economic value. In addition, because the site in question is a protected area under the Natura 2000 network, the types of land benefits and ecosystem services provided are likely to be more widely recognised and valued, e.g. the preservation of threatened species and habitats, leading to a higher estimate of total economic value. Conversely, it is also important to recognise that the hypothetical nature of the CVM means that individual responses are not necessarily indicative of actual behavioural choices, or real purchase decisions. As a result, it is widely accepted that CVM can often lead to problems of overestimation (Blumenschein et al., 1998). For this reason, the value of €260,229.58/ha could also, in this case, be an overestimation of total economic value.

3.2.1 Data on prices of developed land

As a prerequisite of the EP, data on prices of developed land, or undeveloped land for which permission has been granted for development (i.e. commercial, residential, industrial development) must be collected. The data should be representative of lands adjacent to (i.e. in the region of) those natural sites where estimates of total economic values have been gathered.

At the aggregate level, Eurostat is the currently the only public database available that provides data on land prices at the EU and national level. These values however, focus predominantly on agricultural land types, and lack the geographical detail for analysis at a regional/provincial scale. Other official sources include national government agencies and national statistical offices, which record periodic data on land prices, examples of which are; the National Land Agency in Italy, and the Regional Ministries for Territorial Planning and Housing in Spain. However, in some cases the values reported to government and which inform official statistics, differ from actual market prices, due to the large variation in sources and subsequent methods for collecting data on land prices (EEA, 2010). Furthermore, the official data and literature available on the market valuation of land is extensive for agricultural land types, but is often lacking for alternative land uses, i.e. land zoned for particular development purposes (Swinnen et al., 2008).

[7] Value based on study from Bellu & Cistulli (1997) on the economic valuation of forest recreation in the Liguria Region of Italy.

[8] Value based on study by Hoyos et al. 2007 on the WTP to preserve a natural area in the Basque Country, Spain.

Despite the scarcity of official market data on development land in many European countries, a select few government agencies do provide public data on this topic. The UK is one example of a country that collects and reports official data on the land market. The Valuation Office Agency (VOA) is responsible for collecting data on the real-estate market, and provides the government with valuations and property advice to support taxation and benefits across the UK[9]. Until 2011, the VOA published annual property market reports, which included price information on land markets across England, Wales, Scotland and Northern Ireland. The report provides a breakdown on the agricultural, residential, and industrial land markets across 10 regional districts, covering nearly 30 widespread locations throughout the UK (VOA, 2011). Other European countries providing official data on national land markets include; i) the Federal Statistical Office in Germany, which publishes prices on undeveloped and developed building land at the national level, and; ii) the Surveying and Mapping Authority of the Republic of Slovenia, which provides regional data on prices for building land, including residential and commercial land.

For the remaining countries, some public data on prices for development land can be accessed through annual country-level property market reports published by private real estate agencies. For example, Colliers International is a global commercial real estate services organisation that provides valuation and advisory services for the hotel, industrial, office, commercial, and residential property sectors in over 67 countries[10]. For some European countries, the organisation publishes general market review reports, or in some cases land market research reports, with a breakdown of data on annual or quarterly sales for various building land types. One example is the Poland Research and Forecast Report (2013), which provides average values of land for commercial and residential development in Poland for select urban and rural districts based on regional property market sales (Colliers International, 2013). Other examples of agencies offering real estate and land valuation and advisory services are; Ober Haus, which publishes annual property market reports for the Baltic Region, and Naiglobal, which provides local and regional property market research, including quarterly and annual reviews and real estate data for over 15 European countries.

Based on these findings, it is evident that there is much difficulty in finding a consistent approach for locating regional-level data on prices for development land across Europe. The availability of official public data on European (non-agricultural) land markets is often scarce, and where available, discrepancies between government records and 'real' market data may exist. Although some real estate agencies provide a small respite from this problem by offering alternative research solutions, i.e. through data published in market research reports etc., differences in methodological approaches and data sources between agencies is still an

[9] More information on the VOA can be found at: https://www.gov.uk/government/organisations/valuation-office-agency

[10] More information on Colliers International Services can be found at: http://www.colliers.com/en-us

underlying issue. With that being said, as it stands there is no viable alternative solution for garnering a more a robust dataset, notwithstanding the limitations and uncertainty associated with this, the data accumulated should still serve to provide valuable insight and contribution to the analysis.

The final database consists of land price values in lands matching the regions of approximately 95 natural land sites, in 12 European countries: Poland, Spain, Estonia, the Netherlands, Italy, Turkey, Germany, Belgium, Greece, Sweden, Finland, and the UK. Once the data was collected, all values were converted to EUR 2014 prices by controlling for differences in space (PPP) and time (CPI), following the OECD guidelines described previously.

3.3 Application of the Equivalency Principle

For illustrative purposes, let us imagine two pieces of natural land, namely N_1 and N_2, located in the same area and have identical environmental and geographical characteristics (slope, ecosystem, proximity to infrastructures…). Having both the exact same characteristics today, the current price of both pieces of land would be the same. If their features don´t change and both plots remain in a natural state in the long term, their utility is expected to be the same. However, if one of the lands is granted development permits, its market price will automatically increase, while it is most likely that the value of the natural piece of land is not fully recognised by the market. In this situation, Chiabai et al. (2013) argue in favour of using the discount rate to ensure that the present value of both plots is made equivalent, regardless whether they are classified as natural, residential or industrial land. This assumption is the ground for the development of the so called Equivalency Principle (EP).

In practical terms, when a land plot N_1 is classified as urban (U), either for residential or industrial uses, then $N_1 = U$; while N_2 remains as natural land on its original state (N). In this situation, the price of the urban parcel would be greater than that of the natural piece of land ($P_{N1} = P_U > P_{N2}$) and this change could have significant implications for future generations. The value of N2 is usually estimated as the present value per hectare (PVN) by non-market valuation methods. This value should represent the total economic value (TEV) of the natural land that comprises use and non-use values as explained before. Using the conventional equation for the present value, the EP is expressed as follows:

$$PVN = \sum_{t=1}^{T} \frac{V_N(1+g)^t}{(1+d)^t} \tag{1}$$

Where PVN is the discounted flow value of the natural land in time; V_N is the TEV of the natural land in time t; d is the discount rate to be applied on the natural land; PU is the price per hectare of the land with the right to be built upon and g stands for the growth rate or appreciation of benefits of the undeveloped land over time.

In the long term, we can assume that the land provides benefits in perpetuity. For infinite time scales, the equation changes as follows:

$$PVN = \sum_{t=1}^{T} \frac{V_N(1+g)^t}{(1+d)^t} \approx \sum_{t=1}^{T} \frac{V_N}{(1+d-g)^t} \quad (2)$$

When time tends to infinity the formula can be simplified to the following expression:

$$PVN = \frac{V_N}{(d-g)} = PU \quad (3)$$

The main purpose of the EP is to find the appropriate discount rate g that provides a balance to the different value given to each piece of land based on their land-use classification, i.e. natural vs. residential or industrial. Solving Equation 3 we obtain the rule to be applied:

$$d = \frac{V_N}{PU} + g \quad (4)$$

Equation 4 shows the principle to estimate the discount rate considering increasing flows of benefits over time. If growth is not taken into account, g would be equal to zero.

In the present analysis V_N is the TEV in euros (2014) per hectare per year found in each of the valuation studies included in the database (see sections 3.1 and 3.2); PU is the price of industrial or residential land available for each site and g represents the per capita GDP growth, following socio-economic scenario SSP2 estimated by the OECD. A scenario with no economic growth has also been considered.

4 Results and discussion

The discount rate is estimated for two socio-economic scenarios. The first scenario considers no economic growth which means that the flow of annual benefits provided by the land remains constant over time. The second scenario assumes that the flow of benefits will grow over time to take into account that people in the future might be willing to pay more for the benefits provided by the ecosystem. In order to consider this aspect, an exogenous growth rate of the TEV has been included, based on the expected growth of real GDP per capita following the socio-economic scenario of SSP2 (middle of the road), developed by OECD[11].

As regards the price of the developed land, we should in principle distinguish by the type of land use, if industrial, commercial or residential[12]. In addition, the reference land should be as close to the natural site as possible. Nevertheless, the available statistics do not always provide this level of detail.

For this reason, in the next section we present the results for the UK as a separate analysis as there are exhaustive databases on the prices of residential and industrial land at the regional scale, which allows an accurate application of the equivalency principle. The latter requires, in effect, applying the price of the land in the administrative unit where the natural site is located or in its proximity and in this respect the UK databases provide accurate information on prices of land at local level. For the other countries, the same level of information was not available, so that we used the prices at a larger scale (e.g. country or capital cities' averages). An additional advantage of the UK database is that it contains prices of both residential and industrial land (though not commercial). For the other countries, instead, mostly the price of residential sites was available, so it was not possible to differentiate the analysis to this extent.

4.1 Results for the United Kingdom

The estimation has been done for each of the sites in the UK database and the detailed results by site are presented in Table 1 in the Annex. Hereby we report a summary of the ranges of discount rate, classified by land-use type (residential and industrial) and socio-economic scenarios (growth and no-growth) (Table 3).

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[11] Available at: https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=about

[12] Urban land comprises different land uses, such as residential, commercial, etc.

Table 3. Range of estimated discount rates by type of land and economic scenario.

Discount rate (%)	No growth	Economic growth
Residential	0 – 1.71	1.23 – 2.94
Industrial	0 – 3.93	1.24 – 5.16

The discount rate ranges from 0 to 1.7% for residential sites and from 0 to 3.9% for industrial sites, taking into account a scenario with no economic growth (where we assume a constant flow of economic benefits of ecosystem services over time). In a scenario of economic growth (SSP2) the ranges are from 1.2 to 2.9% for residential sites and from 1.2 to 5.1% for industrial sites.

It is important to note that the prices of the land for the UK sites correspond to the value for residential and industrial development, not yet urbanised or industrialized. This is actually the ideal situation for the application of the equivalency principle as we are comparing two pieces of land, both still in their natural state, the only difference being the fact that one has been granted an administrative permit for industrial or residential development, while the other not. However, for other countries the statistical data on prices were not homogeneous.

The results show very low discount rates, especially for residential land, which support policy decision making sustaining the protection of natural land and ecosystems. This is quite crucial when decisions about adaptation measures have to be taken related to the use of natural land. This is the case for example of making appropriate choices between ecosystem-based adaptation and grey infrastructures, which are affecting in different ways natural and developed land uses. Also, it can be expected that in the future natural resources will be under major threat (due to climate change and environmental degradation), so that it can be reasonably expected that their scarcity will induce an increase in their economic value.

The magnitude of the discount rate depends on the price of the developed land and on the TEV. The higher the price of the land the lower the discount rate, while the relationship is opposed with the TEV. The latter is generally much lower than the price of the residential/industrial land of many orders of magnitude, so that the resulting discount rate is generally low.

The overall results show that both the economic scenario and the type of land-use have an effect on the estimated discount rate. In the no-growth scenario the lower bound discount rate approximates zero for both types of land (due to the low magnitude of TEV compared with the price of the land), while in the economic growth scenario the discount rate increases till 1.23% (residential) or 1.24% (industrial), which is basically the projected growth rate of the UK economy. As regards the land-use, the prices of industrial sites are always much lower than those for residential areas, so that the change in the discount rate is attributable to this effect.

The next step was to explore if the type of habitat could play a role in the characterization of the discount rate. For this purpose, the types of ecosystems recorded for each study in the database have been grouped within broad categories of habitats and the discount rate has been modelled accordingly. Table 4 shows the results by type of habitats, as well as by land-use and socio-economic scenarios (with two elasticities used to project the economic flows of the land benefits, 1 and 0.57).

Table 4. Estimated discount rates (%) by type of habitat in UK.

Habitat	Land-use type	No-growth	Economic growth
Coastal habitats	Residential	0.02 - 0.24	1.26 - 1.54
	Industrial	0.07 - 0.89	1.32 - 2.39
Forests	Residential	0 - 0.71	1.24 - 2.24
	Industrial	0.01 - 1.61	1.25 - 3.51
Grassland	Residential	0.19 - 0.32	1.43 - 1.69
	Industrial	0.51 - 0.85	1.76 - 2.27
Mountains	Residential	0 - 0.88	1.23 - 2.16
	Industrial	0 - 1.85	1.24 - 3.18
Wetlands	Residential	0 - 1.63	1.24 - 2.89
	Industrial	0.01 - 3.74	1.24 – 5.05

As discussed above, the discount rates are generally higher for industrial lands and for scenarios assuming economic growth. For the sake of clarity, Table 5 presents the summarised ranges of estimates by habitat.

Table 5. Range of estimated discount rates by type of habitat in UK (summarised results for maximum values).

Habitat	Discount range (%)
Coastal	0.24 – 2.39
Forest	0.71 – 3.51
Grassland	0.32 – 2.27
Mountains	0.88 – 3.18
Wetlands	1.63 – 5.05
Others	0.5 – 2.8

The highest rates are reported for wetlands (with values ranging from 1.63% to 5.05%), followed by forests and mountains (showing approximatively the same range, between 0.7-0.9% and 3.2-3.5%). Finally, grasslands and other habitat show the lowest values. The influence of the habitat has, nevertheless, to be attributed to the economic value of the land (TEV of the natural land and market price of the developed land), and therefore to the antecedent development that took place in the corresponding area within the habitat and in its surroundings, in terms of residential/industrial expansion and environmental safeguard/degradation. A scrupulous analysis in this respect can reveal previous decisions on the use of the territory and highlight contingent disequilibrium between VET and price of developed land. As regards wetlands, for example, we can see that the TEV show the highest values while the average price of residential/industrial land is among the lowest. On the one side, the high TEV might reveal that the social preferences recognize the uniqueness and relevance of this habitat. On the other side, the low price of land might be a sign of the fact that this habitat has not been a priority objective for the industrial or residential development. As regards coastal habitats, the interpretation could to be the opposite. People seem not to attach a high value to these habitats (which basically comprise shoreline, coastline areas and dunes), while their location seem to be optimal for industrial and residential development.

Table 6. Average TEV values and prices of urban and industrial land-uses per type of habitat. Values are measured in euros (2014) per hectare per year.

Habitat	Average TEV €/ha/yr (2014)	Average Price of Residential Land (€/ha/2014)	Average Price of Industrial Land (€/ha/2014)
Coastal habitats	2,363.57	2,015,883.28	703,657.37
Forests	1,951.69	2,712,476.91	866,395.12
Grassland	4,222.27	1,529,028.45	604,764.98
Mountains	5,353.07	2,185,141.40	1,026,959.41
Wetlands	10,054.69	1,894,169.57	608,968.91

The application of the equivalency principle represents therefore a key instrument to re-establish the “equivalency” between the economic importance of the two types of land (natural and developed). In practical terms, this means that in a context of climate change, when choosing between adaptation measures, the discount rate resulting from the application of the equivalency principle can favour the protection of natural land which has suffered from more intensive urbanization processes, because its value has not been sufficiently recognized in past decision-making over the territory. Additionally, this rule reinforces the concept that discount rates should differ geographically taking into account the local specificities including the preferences of society on development and environmental policies.

4.2 Results for all countries

The available information for TEV values and prices of land for development for the rest of the countries was not as exhaustive. As already mentioned, most of the values are indeed for residential land, though for four countries (Finland, Greece, the Netherlands and Sweden) information was also available for industrial and commercial uses.

However, for these countries, prices were only found for the capital cities and this represents an important limitation of the results, for two main reasons. First, because ideally the EP should be applied using TEV and artificial land data from the same area, at the local or regional scale. Second, prices from capital cities will probably be among the highest of the country, and therefore the estimated discount rates will tend to be lower. We report here below the estimated discount rates by country and socio-economic scenario (Table 7).

Table 7. Summary of estimated discount rates (%) by country and economic scenario.

	No growth	Economic growth
Belgium	0.13 - 2.05	1.45 - 3.54
Finland	0.01 - 0.03	1.31 - 1.33
Greece	0 - 3.18	1.52 - 4.26
Italy	0 - 0.35	1.32 - 1.64
Netherlands	0 - 1.39	1.24 - 2.61
Poland	0.59 - 1.97	2.35 - 3.84
Spain	0 – 3.07	1.21 – 4.10
Sweden	0	1.24 - 1.25
Turkey	0.01	1.33

Though we present the results by country, it makes no sense to do a comparison among countries for several reasons. First, the estimated discount rate depends on a number of factors: social preferences about the natural site, decision-making affecting territorial planning and market prices of the land. These factors have obviously a strong geographical component that varies among countries and within each country. So, within the same country, discount rates can be expected to vary considerably depending on the site under analysis. Second, there is a great heterogeneity of the data in terms of land use type, scale and representativeness of the sites included in the database in each country.

Nevertheless, the key contribution of this work is to show that the EP can be employed in completely different contexts, moving towards the definition of different equivalency principles. Furthermore, in a context of adaptation to climate change, the purpose of applying this rule lies in the opportunity of choosing the discount rate which guarantees a sustainable reallocation of the land. In this way, we are able to take into account the different dimensions of sustainable development: economic, environmental, social and institutional.

In the next paragraphs, only for illustrative purposes, we discuss the discount rates obtained for three countries and we explain some reasons behind the results.

In the case of Belgium, TEV values were found to be quite low compared with the average value in the database (Table 2), ranging from 1,467.15 to 4,163.68 EUR (2014) per hectare per year. The latter corresponds to salt marsh areas in the Scheldt Estuary while the lowest TEV values were obtained for forest ecosystems. In relation to artificial land, only prices for land granted with permission for residential development were found, which varied depending on the size of the land. The estimated discount rates range from 0.13 to 2.05% in the no-growth scenario, while in the economic growth scenario the estimates provide a range between 1.45 and 3.54%.

In Finland, TEV values were found to be even lower, namely 424.83 and 494.56 EUR (2014) per hectare per year. Both values were obtained from the assessment of forest ecosystem services in the North Karelia Province, while prices for residential and industrial land were referred to Helsinki. As a result, the discount rates obtained for Finland are very low: in the no-growth the range is 0.01-0.03% and in the scenario that includes economic growth the estimates vary from 1.31 to 1.33%. Also, the range of the estimated discount rate is smaller than in the case of Belgium because the reference values for TEV are all of similar magnitude.

TEV values in Greece present high variations (three and four orders of magnitude), ranging from 9.20 to 37,865.40 EUR (2014). This strong variation in the values of natural land results in differences of around 3% between the estimated minimum and maximum discount rates, as shown in Table 7.

The overall results suggest in general discount rates quite low, in line with the more detailed results obtained in UK (between 0 and 4.3%).

5 Conclusions

The overall results show very low discount rates in all contexts, supporting the idea that new instruments could be created to support policy decision-making in a context of adaptation to climate change but not only. The application of the principle provides a new way of guaranteeing a sustainable reallocation of the land in the long run perspective, taking into account the many dimensions of a sustainable development which includes economics, society, institutions and environment.

This could be the case of making appropriate choices between ecosystem-based adaptation and grey infrastructures, which are affecting in different ways natural and developed land uses. Earlier contribution by Chiabai et al (2013) already illustrated the use of EP when assessing the construction of a new harbour. The construction involved many severe impacts on a Natura

2000 protected piece of natural land. When traditional cost benefit analysis was undertaken the construction of the port could be justified in economic grounds under some conditions. This was mainly because the rate at which environmental assets where discounted was really high, at a market rate. However, when the EP was applied, and as a consequence a much lower discount rate or the assessment of the natural resources, the investment could not be justified under any of the scenarios studied. One can imagine many other situations in which the application of EP can make a difference towards stricter protection of the natural assets. Any analysis of flood prevention measures in which hard infrastructures are opposed to softer nature based solutions could be a good ground for application of the EP. Other applications could follow for health related adaptation measures such as air conditioning equipment versus planting more threes and vegetation in cities to ameliorate the effects of heat waves or any other analysis in which a value of a natural asset has to be discounted.

A much more ambitious development of this approach would involve developing a Global Climate Discount rate (GCD) to be applied for most markets. This could be based on the fact that, we should be calculating the discount rate that will allow us achieving the 2 degree C average temperature increase target agreed in UNFCCC framework. Future research will allow us to estimate this rate and explore other applications of the EP.

For the case analysed in this work, the magnitude of the discount rate depends on the price of the developed land, the TEV and the socio-economic scenario. If growth is not taken into account, the lower bound discount rate approximates zero while in the economic growth scenario the discount rate is much higher following the expected growth in GDP.

The higher the price of the land the lower the discount rate, while the relationship is opposed with the TEV. The database constructed highlights the big difference in the magnitude between non-market values of natural land and market prices of residential/industrial land. This is related to the fact that a piece of land, when granted with an administrative permit to construct, will see a significant increase in its price as it becomes more attractive for market transactions. This is independent from its environmental and site attributes. This explains the low discount rates obtained in the analysis in all countries.

In addition, there is another issue that contributes also to the low values observed for TEV, as these are expressed per hectare. The use of a common unit of measurement is crucial in the economic valuation to make comparison between different things, but the inconvenience is that the calculation of the value per hectare is made by simply dividing the TEV of the whole site under analysis by the number of hectares of the site. What happens is that the value per hectare might result in low estimates for large sites and high values for small sites, though the total TEV might be similar in magnitude. This leads to an unrealistic situation as the value per hectare is not actually reflecting the true value of each hectare of the land.

In welfare economics, it is generally accepted that the size of the natural site affects its value per hectare (the bigger the area, the lower the WTP obtained in per hectare terms), in accordance to the concept of decreasing marginal utility. This is confirmed in several meta-analyses of ecosystem values such as Woodward and Wui (2001), Ojea et al. (2010) or Ghermandi et al. (2010) for wetlands, as well as in the non-market valuation literature (Loomis and Ekstrand, 1998).

Though this is correct from a utilitarian perspective (where the consumer is the main subject), it generates nevertheless some incoherence from an ecological point of view. Indeed, the ecological perspective shows that usually a large habitat is the result of a low fragmentation and a better preservation, and therefore it will have a higher ecological value, not only as a whole but also in terms of each individual hectare. This aspect cannot be captured in the classical approach of economic valuation.

The application of the equivalency principle might also be a path to answer to the issue highlighted above. As the value per hectare of these ecosystems is lower than what could be expected from an ecological point of view, the associate discount rate will be also smaller, allowing a re-balance of the value of the site compared with the developed one.

In the same line of reasoning, from a biological and ecological perspective, rigorous economic assessment would require to address issues related to non-linearity, thresholds effects, spatial variability and irreversible changes (Bagstad et al., 2014; Chiabai, 2015).

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6 Annex

6.1 Table 1. Detailed results for the UK

ID Study	Region	Main habitat	Discount rates (%)		
			No growth	Economic growth	
				ε = 1	ε = 0.57
12	Essex (Blackwater Salt Marshes)	Wetlands	0.1 – 0.3	0.5 – 1.3	1.4 – 1.6
15	North Lincolnshire	Grassland	0.2 – 0.3	0.5 – 0.9	1.4 – 1.6
42	Scotland, Dumfries and Galloway	Wetlands	0 – 1.6	0 – 3.7	1.2 – 2.9
44	Norfolk, England	Wetlands	0.4	1.5	1.7
52	Norfolk, England	Wetlands	0.1 – 0.4	0.3 – 1.6	1.3 – 1.7
56	Highland Perthshire, Scotland	Mountains	0	0	1.2
57	Norfolk, England	Coastal habitats	0 – 0.2	0.1 – 0.9	1.3 – 1.5
63	East Sussex, England	Wetlands	0.1	0.3	1.3
65	Bracknell, Berkshire	Forests	0	0.1	1.3
67	Mar Lodge Estate (Scottish Highlands)	Forests	0.2 – 0.3	0.3 – 0.6	1.5 – 1.6
68	Bedfordshire, England	Forests	0	0	1.2
69	North Yorkshire	Forests	0.7	1.6	2.2
70	Yorkshire, England	Mountains	0	0.1	1.3
71	Gateshead, Tyne and Wear, England	Forests	0.1 – 0.2	0.3 – 1.1	1.3 – 1.5
75	West County Durham, England	Wetlands	0.1 – 0.3	0.2 – 0.7	1.4 – 1.7

6.2 Table 2. Estimated minimum and maximum discount rates per site and country.

ID Study	Site/Region	Country	Discount rates (%)					
			No growth		Economic growth (ε = 1)		Economic growth (ε = 0.57)	
			Min.	Max.	Min.	Max.	Min.	Max.
2	Lesser Poland Voivodeship, Tatra National Park	Poland	0.59%	1.97%	2.36%	3.84%	2.35%	3.78%
5	Guadiana River Basin	Spain	0.00%	0.00%	1.21%	1.21%	1.21%	1.21%
7	Gelderland, Hoge Veluwe	Netherlands	0.01%	0.07%	1.25%	1.31%	1.25%	1.31%
8	Emilia-Romagna Region	Italy	0.00%	0.00%	1.32%	1.32%	1.32%	1.32%
9	Various	Netherlands	0.00%	1.39%	1.24%	2.61%	1.24%	2.62%
11	Northwestern Turkey, Uluabat Lake	Turkey	0.01%	0.01%	1.33%	1.33%	1.33%	1.33%
21	Valencia	Spain	1.39%	1.39%	2.55%	2.55%	2.57%	2.57%
26	Basque Country	Spain	0.99%	3.07%	2.14%	4.10%	2.16%	4.18%
27	Andalusia	Spain	0.02%	0.02%	1.23%	1.24%	1.23%	1.24%
29	Flanders	Belgium	0.53%	1.29%	1.84%	2.61%	1.85%	2.61%
30	Sardinia	Italy	0.01%	0.03%	1.33%	1.34%	1.33%	1.34%
31	Florina, Northwest Greece	Greece	0.09%	2.52%	1.59%	3.58%	1.60%	3.77%
32	Vasterbotten County	Sweden	0.00%	0.00%	1.24%	1.25%	1.24%	1.25%
36	Catalonia	Spain	0.02%	0.02%	1.23%	1.24%	1.23%	1.23%
37	North-east Greece, National Park of Eastern Macedonia and Thrace	Greece	0.00%	0.00%	1.52%	1.52%	1.52%	1.52%
38	North-West Greece ,Zazari-Cheimaditida Catchment	Greece	0.05%	3.18%	1.55%	4.26%	1.56%	4.44%
39	Ionion Island Complex, Zakynthos National Marine Park	Greece	0.00%	0.00%	1.52%	1.52%	1.52%	1.52%
41	Basque Country	Spain	1.30%	2.38%	2.51%	3.59%	2.51%	3.59%
46	Central Limburg Province	Belgium	0.13%	0.51%	1.45%	1.88%	1.45%	1.86%
48	Ilomantsi, North Karelia Province	Finland	0.01%	0.03%	1.31%	1.33%	1.31%	1.33%
49	Ilomantsi, North Karelia Province	Finland	0.01%	0.02%	1.31%	1.32%	1.31%	1.32%
50	Flanders	Belgium	0.84%	2.05%	2.22%	3.54%	2.19%	3.46%
66	Liguria	Italy	0.00%	0.35%	1.32%	1.64%	1.32%	1.65%