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Extracting a Benefit Transfer Function from CV studies Final report

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Work Package 4.1

Extracting a Benefit Transfer Function from CV studies

Final Report

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0. Objectives of the DELOS work package 4.1: Extracting a Benefit Transfer Function from CV studies

In the DOW, WP 4.1 originally included three teams: UB with 6 person months, UR3 with 2, and UTW with 6. Both UB and UR3 decided to reallocate their person months to WP 4.2 for reasons explained in the report of the Barcelona meeting. The WP leader is UTW.

The objective of this WP was to develop criteria to build a transfer function and to transfer Contingent Valuation (CV) monetary values of changes in environmental quality from other case studies in Europe.

In the description of the work, it was stated that a review of recent Contingent Valuation Studies on Beach Maintenance and protection of Natural Habitats in coastal zones would be done and that a statistical analysis would be performed to extract a Benefit Transfer Function from existing CV studies.

As will be seen in this report, the scarcity of the data and scientific thoroughness forced us to widen somewhat the scope of the WP. First, we have included not only CV studies but all kind of valuation studies, and not only changes in environmental quality but any change relating to coastal erosion. Second, we have looked at all kinds of coastal sites and not only beaches and natural habitats.

The original deadline was set at month 12 but the WP has been suspended for several months in order to collect more data. The current deadline was set at month 24.

This report is organised as follows. In the first section, we recall the principles of economic valuation. We felt that this was an important step in a multidisciplinary project such as DELOS. Second, we present the techniques of benefit transfer as they are developed in the literature. Third, we review the benefits and costs of coastal defence. We start with a list of conceptual benefits and costs, and then review the existing evidence for each type of benefit and cost. The reader will realise here that the evidence is scarce. Section IV is dedicated to the transfer of value for informal beach recreation. This is the only type of benefit of coastal defence for which we were able to collect enough data to attempt a benefit transfer exercise. We present regression results and a measure of the risk of error when transferring values. Section V concludes.

I. Principle

It is useful to start with a definition of value in economics. The essential concepts are the Willingness To Pay (WTP) and Willingness To Accept (WTA), which are meant to measure in monetary terms the utility or well-being. The WTP is the maximum amount of money a person is willing to exchange to acquire a good or service that he considers desirable. Conversely, the WTA is the minimum monetary compensation a person would require for parting with a good or service he considers desirable. The two measures are generally only equal in the case of market goods (goods that are exchanged on markets), for non-market goods (not exchanged on market, such as the protection or the landscape offered by a coastal defence scheme) they are not usually equal. The fundamental difference between the two measures is the property rights associated with the item being valued: in the case of WTP, the person acquires the good, he does not own it; in the case of WTA, the person owns the good. The term "owning" here has a general meaning of "being entitled to the services of the good", so that the definition applies to market goods as well as to non-market goods.

The economic value does not refer to an exchange of money or to a price, the goal is to convert "utility" or "well-being" into a money to match it against monetary costs such as those of building a coastal defence scheme.

This is the conventional definition of value in economics, but a non-economist may wonder why we are using it instead of concrete monetary flows such actual prices paid and businesses' benefits. The critical reason comes from the notion of public good: public goods are non-market goods that are non-excludable and non-rival, at least to some extent. A good (or service) is excludable if it is possible to exclude someone from consuming it. A good is rival if its consumption by someone prevents anybody else from consuming it. Coastal defence is to a large extent a public good: a defence scheme can be "consumed" by an additional individual at no extra cost (e.g. if someone builds a house on a defended seafront, he is not reducing the level of protection of the other houses on that seafront), and excluding someone from the benefit of coastal protection is usually not possible.

Because of these characteristics, it is not possible to sell coastal defence on a market.[1] This is a classic case of market failure, but public provision is possible. Therefore, a public body of some

[1] Small structures that defend a single house against shore erosion can be bought in the region of the Great Lakes in the USA, but they bear very little resemblance with the defence schemes that are of interest in this report.

kind (e.g. a government) provides the defence scheme. Because a government is the expression of the will of the public, any action that the government takes should result in an increased public satisfaction (or well-being). But a government is not a business and cannot charge the consumers for the goods that it provides, and therefore it cannot know directly whether the public desires such goods. Economics addresses this issue by converting the change of well-being into money, and compare it to the actual money that has been spent on providing the good. The basic assumption is that if the sum of the WTPs of every member of the public is larger than the cost, then we could in theory charge each such member for at most their WTP to finance the good. This is the essential reason why the economics concept of value is the WTP; it is very much a vision constrained by resources: how much of society's resources is it reasonable to spend on a given public good? This is why economics wants to convert individual utilities for a public good into a measure of what resources those individuals would be willing to sacrifice to acquire that public good.

In practice it is of course not possible to charge each citizen for each public good that is provided, for a variety of reasons. First the cost of collecting the money would surely be prohibitive. Second, the government cannot actually know each individual WTP because of the problem known as free-riding: from an individual point of view, since I cannot be excluded from consuming the good, then I can always claim that my WTP is zero and still enjoy the good. Therefore, the government raises taxes to finance the provision of all its public goods at the same time. Applied welfare analysis has designed several methods to estimate the sum of WTP for each public goods, the aim of such estimation is to offer guidance for public decision.

Defining economic value is important because it makes clear that a broad class of benefits should be considered in a cost benefit analysis, not only those benefits generated by a monetary transaction. As explained, economic value is concerned with any change in well-being, and therefore includes intangible as well as tangible benefits and costs. For example, the change in landscape caused by a defence scheme may affect the well-being of the residents of the area, and thus is part of the economic value.

To complete the definition of economic value, it must be added that such a concept should in general be restricted in the following sense. Cost benefit analysis (CBA) indicates which one of a set of projects is most beneficial (in the sense defined above), but that set of projects should be restricted in the first place by equity considerations, precautionary environmental standards, and regional economic constraints. CBA relies essentially on the concept of economic efficiency (best use of the resources spent on the public good), but efficiency is not the only goal of public policy, this is why CBA must be "tempered". Such restrictions are also an efficient way of limiting the set of projects under considerations in the sense that it is often cheaper and faster to verify whether a project satisfies a certain restriction than to estimate its costs and benefits.

Finally, it is reasonable to state that not all values can be converted into money. Several cases may arise. The most dramatic case is the essential goods: goods that a person cannot do without (e.g. food). Obviously, these goods have infinite values. We will not in general be confronted with such goods in coastal defence projects. A more common case originates in the difficulty of valuing. For example, some changes in biodiversity are very difficult to understand for non-specialists, e.g. changes that affect only microscopic species. In these cases, measures of value are quite uncertain, and it may be more reasonable to have specialists design a restriction on biodiversity.

Scale, economic activity and transfer

The scale refers to the projected impact of the scheme in the sense of the human population that is concerned. This is reflected directly in the funding institutions: if the scheme is deemed of European impact (for example because it protects an architectural heritage of European interest), then it will likely have EU funding. We can distinguish three more levels: national, regional, and local. The level of funding reflects the population that is paying for the scheme, and that is therefore entitled to its benefits: the computation of benefits will be different accordingly with the level of funding.

The scale is important to define what is considered a transfer of value instead of a creation or destruction of value. Assume for example that under some defence scheme, a certain commercial or industrial activity (e.g. a factory located near the shore) will be lost to the sea. If there is abundant enough supply of that activity, then all the business lost to the sea will go to other firms of the same activity. This is a transfer of revenue, not a loss of value. This is the main reason why loss of commercial or industrial activity is usually not accounted for. Likewise the creation of an activity is not considered a benefit since all the attracted business is a loss somewhere else.

Because the abundance of the supply matters, the scale is critical: if the funding is only local, then it is more likely that there is no other supply of the activity, and then, we should count the loss (or the benefit). But if the funding is national or European, then it is highly unlikely that there is no other supply.

We still account for the loss of commercial and industrial buildings in the same way as we do for residential housing. It is also possible to account for the consumers’ welfare loss caused by increased travel time and expenses to the closest supply of the lost activity. Apart from travel costs, another exception to the rule of not accounting for changes in commercial or industrial activity relates to the monopoly position of the activity in its market. Clearly, if the firm is in a monopoly position, its disappearance is a net welfare loss, at least when it is unable to relocate. A less exceptional case may occur when the firm is in an oligopoly position, in which case its disappearance, when it is unable to relocate, will increase the degree of oligopoly in the market. It is well known that this causes a net welfare loss, as documented in standard economic textbooks. The position of the literature appears to neglect entirely these effects. It is deemed that changes in travel costs are negligible, and that firms in an oligopolistic market are able to relocate. This position may be due in part to the difficulties involved in such computations.

A final exception regards agricultural activities: since the soil is necessary for agricultural production, relocation is never possible, and thus loss of agricultural production should always be accounted for. This is however more difficult than it may appear at first because in the EU, agricultural prices are distorted and the market price is not a good indicator of the value of production. We will come back on that point later.

We should also mention here local initiatives to increase tourism, for which tourism receipts are often accounted. First, one should bear in mind that local tourism is conditioned by cultural and geographical factors, and that therefore it is always to some extent unique. In that sense, there is creation of value: the exploitation of local natural resources previously unexploited. To some extent, local tourism is in a position of monopoly. On the other hand, increasing the supply of tourist facilities basically reduces the demand for the existing facilities, that is, the new facilities simply steal some consumers away from the old ones. In that sense there is no creation of value, except from a local point of view that does not take into account the benefit and losses of its neighbours. This is a commons problem: any municipality on the seafront may want to develop tourism, leading to excess supply from a national point of view, with the well-known consequences of turning the coast into a concrete wall, or an artificial beach. This is the reason why some nations (such as Spain) have made development at the coast a national competence.

II. Techniques of Benefit Transfer

Benefit transfer is a series of techniques with the aim of inferring the benefits of a given policy at some new site (called policy site) from the benefits of similar policies already estimated for sites (called study sites) similar to the policy site. Applications have been concerned mostly with environmental policies. Benefit transfer is faster and cheaper than actually estimating the benefits for the policy site (that is, doing an original study), but its reliability is dubious, we quote Brouwer (2000):

> "The technique [of benefit transfer] is controversial, not least because of academic and political reservations over the usefulness and technical feasibility of economic valuation tools to demonstrate the importance of environmental values in project or programme appraisals. Testing of environmental value transfer so far has been unable to validate the practice. Taking into account the conditions set out in the literature for valid and reliable value transfer, most transfers appear to result in substantial transfer errors."

There are three main techniques of benefit transfer:

- **Benefit value**, in which the value of one study site is directly transferred to the policy site. The non marketable goods need to be the same, the population characteristics should be similar, and one has to take into account that value estimates may vary over time. This technique has been found to be very unreliable.
- **Benefit function based on single studies**, in which the value of one site is expressed as a function of socio-economic characteristics only, and the transfer exercise is done to a similar site, applying the same function, with different levels of the socio-economic characteristics. In other word, this transfer relies on a function estimated in the original study, no computation, other than simple substitution, is necessary for that transfer. The single study benefit function cannot depend on the characteristics of the site because those are constant in the study site. For example, at one study site, the width of the beach is unique (it may vary at different points in space of the study site, but this is a single beach). Therefore, it is constant in the benefit function, and its impact on value is not identified. This technique has proven quite unreliable, but sometimes useful for decision making.
- **Benefit function based on multiple studies**. Sometimes referred to as meta-analysis, the benefit function is now constructed by the researcher who does the transfer as a summary of the benefit functions in each separate study. This summary function depends upon socio-economic, site, and valuation method characteristics in an attempt for variations across studies. If the

parameters associated with the valuation method are significantly different from zero and the elicited values are conceptually the same, benefit transfer is deemed unreliable in that particular situation; if they are zero, then benefit are transferred adjusting the socio-economic and site characteristics for the new site. This technique has proven sometimes reliable, but requires numerous studies, and is more data demanding.

The statistical specification of the benefit transfer exercise based on multiple studies is still evolving. The general form of such function is presented here (from Brouwer, 2000). Writing *WTP* as the willingness to pay for a given policy, we have:

$$WTP_i = \alpha + \beta X_i + \gamma Y_i + \delta Z_i + \varepsilon_i \,,$$

where $\alpha \beta \gamma \delta$ are parameters, X is a vector of site characteristics, Y is a vector of socio-economic characteristics (often, the sample means), Z is a vector of study characteristics (among others, the valuation techniques that have been used, if more than one; or the year of the study), and i indexes the studies. The term ε represents the conventional statistical error term.

On top of accounting of socio-economic, site and study characteristics, one could also think of accounting for policy characteristics. That would be particularly useful for coastal defence because it would mean accounting for different defence options, such as characteristics of the LCS. This has not often been done in the BT literature because the focus of interest is a comparison of the same policy at different sites. Yet it appears in some meta-analytical papers (e.g. Santos, 1999), so in this report we will consider that the X variables can also include policy as well as site characteristics.

The formula is expressed as a linear combination and can in principle be estimated by ordinary least squares. Several complications may arise however, for example, one may want to take into account that a willingness to pay is by definition at least zero, which requires using truncated regression techniques. Also, it is desirable that the δ coefficient associated to the valuation method that has been used be not significant, otherwise benefit transfer for that kind of site and policy is deemed unreliable. The essential output is that given values of X, Y, and Z for the policy site, and estimated parameters, the above formula produces an estimated WTP. Finally, the linear-in-parameter specification may be an unacceptable restriction (see Feather and Hellerstein, 1997). When the benefit function is non-linear, then the expectation of the value is not anymore the value of the expectation of its determinants and a bias appears.

III. The Case of Coastal Defence

Typologies of values

A public good such as a coastal defence scheme is complex in the sense that it has many kinds of consequences on the seafront and on its residents. For example, on top of changing erosion patterns and flood risk, a breakwater will change the appearance of the landscape, offer some recreational opportunities (sport fishing), and modify the local biodiversity. Therefore, the value of the coastal defence scheme is composed of the sum of the values for each of these changes, provided we are able to avoid double-counting. Often different types of values will require different valuation methods. Typologies of values following Turner, Bateman and Brooke (1992), and following Bower and Turner (1998) are presented. Such typologies are based on the demand for the services of the coast. Ecological value decomposition (e.g. de Groot et al. 2001) will not be presented because it is based on the supply of such services and should produce the same values.

The following table summarises a typical economic decomposition of value for a coastal defence scheme. This table is best interpreted as "motives for valuing" the assets given in the examples. The third column indicates the valuation methods that would be most suitable for estimating each value. This is not an indication that it has been estimated. A description of each valuation method can be found in the bibliographical report of DELOS WP 1.3.

Table III. 0. Coastal Defence Values. Adapted from Bower and Turner (1998).

Value name	Example	Valuation Method
	Total Use	
Direct Use	- Fishing - Agriculture - Transport, navigation	Market pricing (possibly adjusted)
	- Recreation	Travel cost Stated preferences
Indirect Use	- Flood control - Storm protection - Sedimentation - Habitat loss reduction - Landscape - Human health	Market pricing Hedonic pricing Stated preferences
	Non-use and Option use	
Option	- Insurance value of preserving options for use	Stated preferences
Quasi-option	- Value of increased information in the future (biodiversity)	Stated preferences
Existence and Bequest	- Knowing that a species or system is conserved - Passing on natural assets intact to future generations - Moral resource / Non-human rights	Stated preferences

Typologies of coastal assets

The purpose of this section is to present types of assets the supply of which may be modified by a coastal defence scheme. We do not refer to any particular coast;[2] instead, the first step of any coastal CBA should be to carefully map the coast under consideration and project flooding patterns so as to identify what particular assets are threatened. Instead we draw a list of assets, to which the analyst can refer once he has drawn the flooding patterns map (see Bower and Turner, 1998; Fankhauser, 1995; Penning-Rowsell et al. – Yellow manual, 1992; Ruijgrok, 2001).

The potential benefits (or costs) of a coastal defence scheme are achieved by: reducing and mitigating (or worsening) damages; enhancing (or reducing) coastal zone outputs (e.g. recreational); and preserving (or deteriorating) unique coastal ecosystems. To this we must add a list of "second

[2] For a list of actual coastal types, see the web page of the EU Coastal Guide www.coastalguide.org of the EU for Coastal Conservation organisation www.eucc.nl.

round” effects, that is, effects occurring because a direct consequence of the defence scheme has occurred.

- <u>Mitigation benefits or costs</u>.
  - Reducing damage (including preventing complete destruction) to coastal properties from coastal storms and eroding shorelines.
  - Reducing salinity intrusion.
  - Reducing sedimentation in navigation channels and in harbour areas.
  - Reducing sedimentation on spawning beds and coral reefs.
  - Restoration or preservation of habitats e.g. wetlands that have been filled, migratory bird area restoration such as in the Normerven Dutch scheme or planting of sea grass beds outside the Venice lagoon at the Pellestrina Italian scheme.
  - Restoration of recreational opportunities, e.g. sand beach.
  - Human health in the sense that defence reduces the risk of accident (e.g. storm impact).
  - Reducing damages to cultural and heritage assets. Note: buildings can be valued in two ways – erosion can cause complete loss, in that case we seek the discounted value flow of the whole building as in Mendelsohn and Neumann (1995) or Fankhauser (1995 a and b); but erosion may simply mean that the probability of temporary flooding increases, that is only an inconvenience not a complete loss, that would be valued through hedonic models. At the same time hedonic models also serve to capture amenity value (e.g. landscape, proximity to the beach, proximity to interesting biotic or abiotic assets, proximity to cultural or heritage assets). How to combine those two valuations is untold in the literature.
- <u>Enhancement benefits or costs</u>.
  - Increased output of the seafront caused by the defence scheme, e.g. creation of recreational opportunities such creating a sand beach or the use of jetties for recreational fishing or diving (as in Lido di Dante). In general, a LCS can be seen as a type of artificial reef, and thus may increase fish output.
  - Deepening of navigation channels (as a result of the scheme).
  - Finfish and shellfish yield declines.

- Water quality that is affected by changes in marine currents or sewage system caused by the defence scheme; this can be positive (improved sewage systems) and negative (eutrophication, red tides).
- Conflicts among different types of recreation users of beach areas caused by the defence scheme.

- Preservation benefits or costs. This refers to natural areas that are preserved, directly or indirectly, by the defence scheme. One example is the Aldeburgh British scheme in which inland and seafront marshes were indirectly protected by a sea wall. The benefits stemming from the preservation of a natural ecosystem are generally recreational use and non-use. An in-depth case is described in Goodman et al. (1996). Offshore sand and gravel mining (e.g. to find the sand for beach nourishment) that has affected fisheries and habitats. Exotic species appearing at the defence scheme (e.g. when a beach is protected by a hard structure), causing damages to physical structures (e.g. water intakes), damage to indigenous species and ecosystem modification.

- Indirect economic benefits or costs. These are "second round" effects, e.g. assume a defence scheme improves recreational opportunities by allowing scuba diving (maybe because interesting species have settled in). The "first round" benefits come directly from the increased recreational activity (inasmuch as it a net increase, as mentioned in the section about scale). A "second round" benefit may be the establishment of a specialised shop for scuba diving, again assuming this is net to the region or the nation. Constructions in hazardous areas in relation to coastal storms and shoreline erosion that are or will be built because of the protection granted by the defence scheme (resulting possibly in a stronger scheme being necessary in the future, see Cordes et al., 1998 and 2001). Secondary effects are difficult. Consider beach recreation: creating a beach will attract tourism, which in turn will attract commercial development. There is exploitation of a resource, so there is net creation of value. This is dynamic, at first, small scale tourism may appear, the benefit is demand driven, next commercial development will appear, generating a larger demand. The benefit becomes the consumer surplus plus the producer surplus (not the producer revenues). However, if the scale of the defence scheme is local, what matters is the local inflow of money, so possibly, if all the tourism is foreign, it may be only the amount of taxes that can be collected on the commercial development.

The following series of tables present coastal assets per type of value, along with an indication of the reference where a value can be found. The benefit/cost category refers to the type of consequence a scheme may have on the asset. Whether it is a benefit or a cost of a given scheme depends on what we compare the scheme with. The valuation method category refers to the primary valuation method, that is the method that has been used for the original acquisition of data, or the one that would be most recommended. The actual available data may in fact come from reported benefit transfer exercises. The abbreviation Meth indicates that the only reference to that type of benefit comes from one or several methodological references (that is, with no value estimate) to be found in the methodological bibliography in the final report of the DELOS WP 1.3.

Table III.1. Value type: Direct consumptive use

Asset	Benefit/cost	Valuation method	Reference
Commercial and industrial activities, excluding agriculture and fisheries but including tourism, that are not an exploitation of local natural resources or for which there are many substitutes	Loss or gain of activity	Not a net loss or gain, value is zero (in some cases, price rises and travel time may be accounted for)	Meth
Commercial and industrial activities, excluding agriculture and fisheries but including tourism, that are an exploitation of local natural resources or for which there is no substitutes	Loss or gain of activity	Total consumer and producer surpluses (Consumer surplus may be accounted for in recreational value)	Meth
Agricultural activity	Yield change caused by Storm damage, Erosion, Salinity level	Yield market value, adjusted for subsidies	Meth
Fishery (industrial fishing and aquaculture), Non-commercial finfish and shellfish collection and agriculture	Yield change caused by Off-shore mining, Water quality	Yield market value, adjusted for subsidies	Meth
Land for residential, commercial and industrial activities including agricultural land	Loss of land	Value of similar land inland	Yohe et al., Fankhauser

Table III.2. Value type: Direct non-consumptive use

Asset	Benefit/cost	Valuation method	Reference
Recreational fishing, scuba diving, shellfish collecting, wildlife watching, sailing, boating, water-skiing, surfing and similar	Preservation & enhancement of site	Travel cost, stated preferences (value of enjoyment)	Meth
Waterfowl hunting	Preservation & enhancement of site	Travel cost, stated preferences (value of enjoyment)	Loomis and Crespi
Beach visitation	Preservation & enhancement of site	Travel cost, stated preferences (value of enjoyment)	Loomis and Crespi, UK references
Heritage buildings recreational use	Inundation (complete loss)	Travel cost, Stated preferences	Meth
	Flooding risks (temporary inconvenience)		Meth

Table III.3. Value type: Indirect use

Asset	Benefit/cost	Valuation method	Reference
Permanent residential, commercial and industrial non-heritage buildings	Inundation (complete loss)	Building discounted market value (minus goodwill), Hedonic model	Yohe et al., Fankhauser, Dorfman et al.
	Flooding risks (temporary inconvenience)	Hedonic model	Meth
	Other amenities (recreational opportunities, landscape)	Hedonic model, Stated preferences	Meth
Temporary and semi-permanent structures (mobile home, caravan, chalet)	Complete or partial loss	Cost of moving, or resale value (market value minus depreciation)	Meth
Utilities infrastructure: Road, rail, pipelines, cables, sewers, ... Service infrastructure: sport facilities, ...	Complete or partial loss	If local, included in market value of property, else construction cost minus depreciation and obsolence	Meth
Infrastructure: Sea defence itself	No threat	Value is zero, else double counting (capital, maintenance and running costs to be included in option costs)	Meth
Navigation channels	Sedimentation	?	Meth
Human health	Storm control and mitigation (physical casualties)	Hedonic models (risk levels)	Meth
	Flooding discomfort (stress, health effects, loss of memorabilia)	Ideally, stated preferences, but no agreement	Meth
Spawning beds and habitats	Destruction (construction, mining or sedimentation)	Intermediate output: do not account	Value is included elsewhere (fisheries yields, recreation)

Table III.4. Value type: Non-use value

Asset	Benefit/cost	Valuation method	Reference
Ecosystem and natural heritage such as wetlands, dunes, coral reefs, beach, water quality, and off-shore gravel and sand beds.	Preservation for motives of Option, Quasi-option, Existence or Bequest non-use values	Stated preferences	Silberman and Klock (1988).
Heritage buildings	Preservation for motives of Option, Existence or Bequest non-use values	Stated preferences	Meth

Table III.5. Value type: Secondary effects

Asset	Benefit/cost	Valuation method	Indicative values sources
Residential buildings	Induced development	Such development does not occur, value is zero	Cordes et al. (2001)
Commercial buildings and activities	Induced development	See the section on scale. Often, value is zero. Constraints may apply.	Meth
Traffic	Disruption due to change in infrastructure	No convincing method, extra time valued at average wage rate (consumer side only)	Meth

Indicative values per type of coastal asset

In this section, for the 5 tables presented above, whenever available, we present indicative value(s) per type of benefit or cost. For several types of value, there is a single occurrence in the literature; for a few types of values there is a small number of estimates available in the literature. There is only one type of value for which there is a substantial number of estimates, this is informal beach recreation that is studied in detail in the next section of this report. For some classes of benefits (land, bird viewing, waterfowl hunting), benefit transfer results are available in the literature, although their applicability in the context of the DELOS project may be somewhat limited.

Table III.1'. Reported values for direct consumptive use

Asset	Benefit/cost
Land of all types including land for residential, commercial and industrial activities and agriculture	Loss of land
Yohe, Neumann and Marshall, 1999. In the absence of threat, land prices follow the equation $d\left[\ln(P_t)\right] = \alpha + \lambda L + \psi Y + \beta d\left[\ln(P_{t-1})\right]$ where P_t is the real price at t, L is the population growth rate, and Y is the per capita income growth rate. The symbol $d[\ ]$ indicates a growth rate. This equation is estimated for each of the 30 sites in their sample. Land values continue to follow the equation and drop to zero when inundation occurs. The authors estimated the equation with US data, but do not indicate any value directly. For an application, it is necessary to collect local prices and estimate the equation. See Annex II for more details.	
Fankhauser (1995). Average land value is set to \$2 M/km2 for open coasts and beaches and \$5 M/km2 for wetlands (non-built lands only). See Annex II for more details.	
Fisheries	Yield changes
Farber (2001). M \$ 0.25-0.36 expected over 100 years for 170 km Louisiana barrier islands system through protection from storms.	

Table III.2'. Reported values type for direct non-consumptive use

Asset	Benefit/cost
Bird viewing	Preservation, enhancement
Loomis and Crespi (1999). Value per day of viewing (1992 US $) 29.91 for one viewer in the USA. Other data have shown that a 1% change in the number of birds seen per trip results in a change of .173% bird viewing trips in the USA. It is assumed that a reduction of 1% of wetland area results in an equal reduction of bird population, which in turn results in an equal reduction of birds seen per trip. Transferring to a particular site still requires to know the number of visitors. See Annex II for more details.	
Waterfowl hunting	Preservation, enhancement
Loomis and Crespi (1999). Value per day of hunting (1992 US $) 30.45 for one hunter in the USA, a 1% change in wetland acres results in a .275% change in hunter days in the USA. Transferring to a particular site still requires to know the number of visitors. Waterfowl hunting is much more practiced in the USA than in Europe, it is not expected that this value can be transferred to a European context. See Annex II for more details.	
Beach visitation (informal recreation)	Preservation, enhancement
Loomis and Crespi (1999). Value per day of visit (1992 US $) 16.3 for one visitor in the USA. A 1% change in the length of shoreline (in meters) results in a change of .425% change in the number of visits in North-eastern US, of .096% in Southern US, and of .147% in Western US. See Annex II for more details.	
Silberman and Klock (1988); Ruijgrok (1999); Whitmarsh et al. (1999); King, O. H. (1995); Green (personal communication); Hanemann (personal communication): This is the data used in the next section. The data set is reproduced in in the Annex II of this report.	
Penning-Rowsell et al. Yellow Manual (1992). UK£ 7.55 VOE per visit for generic beach.	
Fouquet et al. (1991). UK£ 7.15 VOE per visit for generic shingle bank.	
Costa et al. (1992). UK£ 8.75 VOE per visit for generic promenade.	
NOAA (1995). US$ 11 WTP for use of generic beach per visit (personal communication)	
All recreational seafront activities	Preservation, enhancement
Farber (2001). M $ 1.12-1.33 expected over 100 year for 170 km Lousiana barrier islands system through protection from storms.	

Table III.3’. Reported values for indirect use

Asset	Benefit/cost
Residential, commercial and industrial non-heritage **buildings**	Inundation (complete loss)
Yohe, Neumann and Marshall (1999). Building prices follow $d\left[\ln(P_t)\right] = \alpha + \lambda L + \psi Y + \beta d\left[\ln(P_{t-1})\right]$ with the same symbols as in table 1’. This equation is estimated for each of the 30 sites in their sample. Buildings start depreciating 30 years before inundation in an efficient market and reach zero at T at which time they are abandoned. If the market is not efficient or if abandonment is uncertain then the market has less than 30 years to react and properties do not have a value of zero at time of abandonment, they investigate a scenario of no foresight at all, as if SLR would occur instantly, and the equation applies until T. The authors estimated the equation with US data, but do not indicate any value directly. For an application, it is necessary to collect local prices and estimate the equation. See Annex II for more details.	
Fankhauser (1995). Average value set to \$ 200 M/km2 for cities and harbour. See Annex II for more details.	
Farber (2001). M \$ 15.3 (M \$ 21.5) expected over 100 years for 170 km Louisiana barrier islands system through protection from 90.5º W (91.5º W) storms. 1 km of barrier protects 30 km2 of land.	
Dorfman et al. (1996). Given a probability P of loss, an increase of 1% of the risk of inundation causes a decrease of .2 P % of the house price.	

Table III.4’. Reported values for non-use values

Asset	Benefit/cost
Ecosystem and natural heritage, beach	Preservation for motives of Option, Quasi-option, Existence or Bequest non-use values
Silberman and Klock (1988). US \$ 16.3 as a one-time contribution / visitor.	
Ecosystem and natural heritage, global (large areas including all coastal types of natural assets)	Preservation for motives of Option, Quasi-option, Existence or Bequest non-use values
Goodman et al. (1996). UK£ 48.36 for maintenance, annual for 30 years, for an English or Welsh household for the whole length of the English and Welsh coast (approximately 4 000 km).	

This is essentially all the evidence that exists on the value of coastal defence. In the context of the DELOS project, it is possible that in some circumstances not all economic values are acceptable, but only those that lead a measurable flow of money generated by the use of resources. These are financial values, a subset of the economic values. Often, they are expenditures by visitors and recreational users, and gross income to commercial operations. English Nature Research Reports No. 182 is dedicated to marine and coastal wildlife areas in England and details the methodology of collecting data on the financial values of a given site. This report does not, however, compare the values of specific LCS designs.

The only other known example of such values is a study on the Australian Gold Coast by Raybould and Mules published in 1999. These authors value erosion protection from storm surges for beaches, including nourishment, over a 25 year program for 15 km of beach in the Gold Coast region, Queensland, Australia. What is valued is not the protection in itself, but the prevention of lost tourism revenues (mostly from surfers) and (unspecified) public assets, assuming there is no loss from storm surge when the policy is implemented. They compute that there are 13.2 M overnight visitors and 7.7 M day visitors; 68% of the nights are by domestic visitors, 15% by Queensland residents. They rely on 3 specific incidences of past erosion and their effects on tourist activity (1996, 1990, 1967): 2 events for 1 in 5 years storms, 1 event for 1 in 25 year storms. Their results are that a 1 in 5 years storm implies a 2.5% revenue loss (47 M 1996 Australian $) and an asset loss of 0.75 M; a 1 in 10 years storm implies a 5.5% revenue loss (129 M) and an asset loss of 1.12 M; a 1 in 25 years storm implies a 13% revenue loss (305M) and a asset loss of 5.5 M. This yields a net present value (at 5% discount rate) of 452,1 M (1996 Australian $) for the erosion protection (approximately 272 M □). The authors do not describe in details how the protection is designed.

IV. Evidence on Informal Beach Recreation

Data sets

Our data set comes from essentially three sources. The first one is a library search of published and unpublished papers, including reports and theses. This list of references can be found in the report of the DELOS WP 1.3, there has been few additions since then. The list of references is reproduced at the end of this report.

The second source of data comes from Professor Colin Green (Flood Hazard Research Centre, Middlesex University) who gave us several unpublished results. These results originate from a legal obligation in the UK. Any institution who wants to build a coastal defence work and to claim financial help from the MAFF (Ministry of Agriculture, Fisheries an Food) has to carry out a cost benefit analysis. This analysis has been formalised through the Yellow Manual (Penning-Rowsell et al., 1992) where the rules for valuation are laid out. Failure to follow these rules results in rejection of the claim for financial help.

Unfortunately, there are several shortcomings to this data set. The first is that, although the reports themselves must surely be well documented, we could not access them directly. All our data come from communications with Professor Colin Green. In particular, the data are very scarce regarding the description of each site being valued and the socio-economic characteristics of the local or visiting populations. That means that we have quite a few observations of value, but for each such observation there are few of the possible determinants of value, such as e.g. beach characteristics or respondents' income.

The second type of shortcoming comes from certain aspects of the Yellow Manual valuation procedure itself, comparatively with the international standards applied in valuation (see in particular the report the NOAA panel on contingent valuation – Arrow et al., 1993, or Carson, 1999). The Yellow Manual recommends to apply a valuation procedure called Value Of Enjoyment (VOE). This is a sort of contingent valuation in which the respondents are asked to state an activity which gives them an enjoyment similar to their visit to the beach. The respondents are then asked to think about how much they spend on this alternative activity, and then are asked to place a monetary value on the enjoyment they had from their visit to the beach. Therefore, the VOE is a kind of average of expenses on alternate activities. However, the notion of economic value which is generally admitted in the literature is the maximum willingness to pay. It is doubtful that the VOE corresponds with such maximum since the respondent is guided to think about what he has paid for similar activities, not about the maximum amount he would pay.

Another difficulty with the VOE is that it does not seem to take substitute sites into account. This is important for public decision making; the question that is asked in a context of coastal defence is whether it is worth to spend the cost of the defence. The relevant benefit is somewhat complex because of substitution patterns. Assume a respondent states that he would continue to go to the beach even if it was eroded, then for this respondent, we should consider the lost (personal) value from the current state of the beach to the eroded state. Another respondent could state that instead of going to the eroded beach A, he would go to beach B; in this case, the relevant loss is between beach A in its current, uneroded, state and beach B (beach A in its current state is the best option for the present respondent since his behaviour revealed that he had chosen this beach over all other alternative activities). Yet another respondent could state that if the beach was eroded, he would go to a nature reserve (this option is one of the most commonly stated substitute for beach recreation in England, see Green, 2001). In this case, the lost value is between the beach in its current state and the nature reserve. The literature on valuation has solved this problem by resorting to what is known as Multiple Site Travel Cost Models (see e.g. Herriges and Kling, 1999). But this methodology is scarcely applied for beach recreation.

On the other hand, it is fair to state that the more complex and the more theoretically acceptable the valuation procedure, the more expensive its implementation. Coastal defence projects are not what we call expensive in the field of public decision making, especially because they usually refer to a relatively small area. This is in fact recognised in the UK regulation where cheap coastal defence work can claim financial help from the MAFF by reporting the generic figures provided in the Yellow Manual without carrying a formal valuation study. However, it is also clear that VOE values are difficult to compare with other sources.

The third source of data comes from Professor Michael Hanemann (University of California at Berkeley). This data has been compiled in the framework of a litigation for an oil spill in Florida, precisely to show that recreational values at the beach showed a very large magnitude (1 to 100) and that several studies were flawed (personal communication, the flawed studies were excluded from our data set). Most of this data originates from studies by the NOAA (US National Oceanic and Atmospheric Administration) with the purpose of issuing recommended values for informal beach recreation in the context of damage claims in case of pollution. The NOAA currently recommends a rough value of 11$ per beach day per visitor, but Professor Michael Hanemann, after carefully reconsidering each study, recommends values ranging from 11 to 23$, with an average of 15$ for Florida beaches (personal communication). This reconsideration was admitted in court.

Similarly to Professor Colin Green's data, Professor Michael Hanemann's data are very scarce regarding the physical description of the beach and the socio-economic characteristics of the visitors. On the other hand, they are based on more conventional valuation concepts, essentially the Consumer Surplus from travel cost models and maximum willingness to pay for use of the beach for the contingent valuation studies.

It must be stated clearly at this point that both Professors Michael Hanemann and Colin Green, who are both leading world authorities on the topic of beach valuation and on valuation methodology in general advice against the transfer of benefits related to beaches. They do not consider that the techniques of benefit transfer are wrong per se, but they consider that the evidence that exists to this point is far from meeting the required standards for reliable transfer.

Number of visits

Another general shortcoming of benefit transfer relates to the number of visits. All the available values are per visit to the beach per visitor. Even if there was no added difficulties because of the theoretical concepts to which these values refers, when we want to estimate the value of the beach itself, we still need to know the total amount of visitors to the beach. Even though this information was probably known for several of studies communicated by Professors Michael Hanemann and Colin Green, it was not communicated to us. Counting the visitors to a beach is not easy and is prone to errors.

For valuation of erosion, one is generally interested to the number of visits over the whole year. How is this estimated? There are 2 problems. The first is to actually count the number of visitors to the beach. The recommended option in the UK, when feasible, is infrared counters, but often this is difficult to implement because there are many accesses to beach and one has to calibrate the counters properly (not counting dogs, not counting one bicycle as two persons, …). In the US, they sometimes resort to helicopter for counting the number of people present at a beach at a given moment. Of course, when the investigator is interested in the whole year, he has to take a sample of days during the year to estimate the total number of visits. Professor Colin Green considers that the main problem in valuation of beach recreation is not estimating the individual value, but the counting of visitors.

The second problem related to counting has to do with the number of visits per person. One option is to extract a sample of visitors on site and ask them to recall the number of trips they took during the past year, but of course the respondents may find it difficult to recall exactly how many times they came. Another option is to do a follow-up of each respondent for several months and ask them for example every 2 weeks how many times they went to the beach. This is however expensive and prone to attrition.

Another problem is on-site sample bias. This bias is due to the fact that when we randomly select visitors at a beach, it is more likely to encounter a person who visits often than a person who visits rarely. A small example is illustrative. Assume that out of the population of visitors to a given beach, half goes once a year, while the other half goes once a month. Now let us consider an interviewer on the beach and assume he interviews visitors randomly, this is the standard procedure. On any given day, the probability that he interviews a person who comes once a month is 12 times bigger than the probability of interviewing a person who comes once a year. So, in expectation in the sample, there is 12 times as many people who comes once a month as people who comes once a year. It seems reasonable to assume that the people who come more often will have higher values than the people who come less often. Therefore an average value that does not correct for the on-site sampling bias will overstate the true value. That bias has been discovered by Shaw (1988), there is a correction for travel cost models, but it is not usually applied; the effect on contingent valuation estimated values is yet unknown.

Regression analysis

Given the provisions given before, we will now proceed to the analysis of the data. The goal is to nevertheless attempt a benefit transfer from whatever evidence that we have, not for a proper transfer of benefits (because that would be against the opinion of the leading experts in coastal valuation), but rather in order to offer a summary of the data. Since we often have more than one observations for a single site, we resort to panel data models. As mentioned in the theoretical part of this report, a benefit transfer function is usually linear, at least in the sense of first degree approximation. We used linear panel data. The advantage of such models for our purposes is that because we observe some sites more than once, we can let each site have different intercept term. This intercept can then take into account all the site specificities that are not accounted for in the regressors. To formalise the model, we first remind the prototype model from Brouwer (2001?):

We write V as the value found per site per visit for a given policy, we have:

$$V_i = \alpha + \beta X_i + \gamma Y_i + \delta Z_i + \varepsilon_i \,,$$

where $\alpha\,\beta\,\gamma\,\delta$ are parameters, X is a vector of site characteristics, Y is a vector of socio-economic characteristics (often, the sample means), Z is a vector of study characteristics (among others, the valuation techniques that have been used, if more than one; or the year of the study), and i indexes the studies.

This assumes one site per study, but in our case, for some studies we have more than one observation per site. We now denote V_{it} one value for site i under the circumstance t. The circumstance can refer to a different point in time (a different year), or to some hypothetical situation (for example, the site is eroded). The model can now be written as:

$$V_{it} = \alpha_i + \beta X_{it} + \gamma Y_{it} + \delta Z_{it} + \varepsilon_{it}\,.$$

The main difference is that the intercept term $\mapsto$ is now specific to each site because it is indexed by i. This is critical because the site-specific intercept term will account for all the differences in values across sites not accounted for in the regressors. The site characteristics have now received an additional index t because the respondents can be asked to imagine that the site changes characteristics (e.g. becomes eroded) or because the same site can be valued on different years. Likewise, the respondents will change across years, and the study characteristics (e.g. the valuation method) may be different across years.

Concretely, the regressors that we are able to investigate in this study are described under the next title.

Data description

The final data set that has been used as a starting point for the regressions had 106 observations, but only 38 different sites. Some sites have been observed during more than one year, and for some sites there were hypothetical behaviour questions such as “how much would you value this beach if it was eroded” or “how much would you value this beach if it was defended”.[3] Also, in some cases the value is given by type of visitors to the beach. For all these factors, there is a site with 24 observations, while there are 23 sites with only one observation. Only three countries provide data: the UK, with 79 observations, the US with 22, and the Netherlands with 5. The

[3] The phrasing is of course conjectural because we did not have access to the actual studies, only to summary results.

information on the country will not be included in the regressors since it is in fact already included in the site-specific constants.

We now describe the site characteristics X. Sites are classified according to 3 types: Coastal resort (74 observations), Beach (5) and Dune (2). There are 25 observations for which the site type is not known, but there are reasons to believe that they are coastal resorts, and this is what is assumed from here on. Another variable that is available per site is a rough measure of quality. A site can be in its current state (64 observations), eroded (20 observations) or defended (24 observations). For one site, there were two types of defence schemes (4 observations each), but their influence on the value turned out insignificant (statistically speaking) with respect to the other main type of defence. Thus we removed one of the defence types and assimilated the other to the main type of defence (thus reducing the number of categories for the site quality measure from 5 to 3). There is no other variable describing the site characteristics.

The socio-economic variables Y are equally very sparse. There are 4 categories of respondents: the local visitors (16 observations), the non-local visitors among which those who stay a single day (15) and those who stay more time (15), and those observations for which this distinction is not made. This last category is a kind of average of the other three. For some sites under some circumstances, there was a value for each category. In this case, the average value (the last category) has been excluded from the regressions (15 observations removed). There is no other socio-economic characteristics.

The last category of variables, Z, relates to the study itself. A first variable in this category is the year the study took place, ranging from 1975 to 1995, with the most studies in the early nineties. The following Z variables are available:

Table IV.1 Study characteristics

Value concept	**Count**	**Valuation method**	**Count**	**Payment vehicle**	**Count**	**Sampling**	**Count**
VOE	78	Open-ended CV	89	None	78	On-site	86
WTP for use	13	Bidding game CV	2	Entrance fee	8	Unknown	20
CS	15	TC	15	Unknown	20		

Origin	**Count**
Green	62
King	1
Whitmarsh et al.	16
Ruijgrok	5
Silberman & Klock	2
Hanemann	20

The origin of the study (sometimes the author, sometimes the facilitator of the data) is in fact included in the site-specific constants and will not be used in the regression. We consider that there is too little information in the sampling variable to be of use in the regression. Some of categories of the payment vehicle and of the valuation method variables perfectly match those of the value concept, so these variable are partially redundant and will not be used. Finally, the sum of the dichotomous variables indicating the value concepts are in linear combination with the sum of some site-specific constants, causing perfect collinearity: only one value concept category can be indicated in the regression instead of the two that we would normally expect.

Finally the value itself is expressed per visit per person in □ of 2001, adjusted by the consumer retail price index of the relevant countries up to 2001 and then converted to □ using the average rate for 2001. The average of the values is nearly 17□, with standard deviation around 14, minimum 1, maximum nearly 92.

Panel data regression results

Considering the observations that have been removed for the reasons indicated above, the final regressions are based on 88 observations, but have 44 coefficients including the site-specific constants. This is large by all standards and cast doubt from the outset on the robustness of the results. However, accordingly with the results of the Hausman's test, the random effects panel is clearly better than the fixed effects model. This means that the site-specific constants can be considered random variables. This is a good sign that the regression results can be extended to similar circumstance, and it also reduces the number of coefficients to estimate from 44 to 8.

The date (T) of the study is a cardinal variable and is inserted in the regressions as a natural trend starting in 1975 (normalised to 1). The 4 categories of visitors (local residents, day visitors, stay visitors and unspecified type) are represented using three dichotomous variables (Local, Day, Stay), with the omitted category being the unspecified type. The 3 remaining categories of quality of the site (eroded, current quality, defended) are represented using two dichotomous variables (Eroded, Defended), the omitted category is the current quality. Finally, the concept of value has three categories (VOE, WTP for use, Consumer Surplus). The 3 categories have been represented by 2 dichotomous variables (WTP, CS), the omitted category being VOE. As mentioned earlier, it turns out that the sum of these 2 variables is a vector of zeros and ones identical to the sum of certain site-specific constants; this is a direct consequence of the fact that in many cases any single site has been analysed using a single concept of value. Therefore, one of these 2 variables had to be removed to enable estimation but since the decision to remove is arbitrary, we present the 2 sets of results: in the first one (table IV.2) the variable removed is the dummy indicating the Consumer Surplus, in the second one (table IV.3) it is the dummy indicating the WTP for use.

Table IV.2			Table IV.3		
Variable	Coefficient	P-value	Variable	Coefficient	P-value
T	0.218	0.4933	T	0.222	0.4845
DAY	4.700	0.2224	DAY	6.256	0.1054
LOCAL	1.547	0.6873	LOCAL	3.121	0.4183
STAY	4.116	0.2853	STAY	5.673	0.142
WTP	-15.671	0	CS	15.902	0
ERODED	-8.369	0	ERODED	-8.316	0
DEFEND	3.295	0.0158	DEFEND	3.482	0.0108
Constant	19.383	0.0019	Constant	10.216	0.0834

The first thing to remark from these tables is that they are quite similar with the exception of the constant term. The constant changes because of the two different dummies (WTP or CS), this is reasonable because these dummies indicate a change in the average value of the site, and hence of the constant. The coefficients of the regressors change little, this indicates that the effects of these variables on the value is similar whatever the concept of value that is used. The effect of time (T) is statistically negligible, that is, the value of sites for coastal informal recreation has not changed noticeably between 1975 and 1995. The effect of the type of respondents (Local residents, Day visitors, Stay visitors or Unspecified) is not statistically significant either.

The quality of the site (Current, Defended, Eroded) is unquestionably very significant. This measure of quality is of course very coarse. “Current” refers to the beach as it is at the moment of the study; as far as we can say on the basis of the present data set, this is in fact a wide range of qualities. It merely denotes a coastal site that is enjoyable under normal conditions. “Eroded” indicates a state, usually hypothetical, in which only a narrow range of the beach remains in place, if any. “Defended” indicates that a coastal defence scheme, also usually hypothetical, is implemented that partially modifies the aspect of the beach and may enlarge it. We do not have information about the exact scheme that was used at each site; it is likely that nourishment was the main defence, it may be accompanied at some sites of groynes or boulders. This is only a guess from the information that we have: a coastal site is usually the object of a study at a stage in which it is already somewhat eroded, the defence scheme aims at restoring it to previous levels. This is more true for UK sites than for US sites because in the US several sites were investigated in a context of litigation for oil spill or of pure scientific research.

Finally, the high significance of the concept of value used (VOE, WTP for use, Consumer surplus) is worrisome. It is acceptable that different concepts of value yield different values, but the problem is that different survey design (Open-ended CV or Travel cost model) have been used for the different concepts. Therefore, we cannot tell whether the differences in value are genuine or are led by the method used. If it is the former, we would still have to decide which concept of value is more appropriate. If it is the latter, then benefit transfer of informal beach recreation is flawed since a different method leads to a different value for the same beach. We can accept that for certain situations, the researcher was imposed the method (for example in the UK, only open-ended CV is admissible for claims of funding to the MAFF), but in general, this demonstrates a lack of standards in applying valuation to beach recreation. On the other hand, it is possible that the value concept variable are capturing some of the site or socio-economic characteristics because VOE is only used in the UK and CS is mostly used in the US. The average value is around 16 for the UK and 22 for the US sites. So, even though the site-specific constants are designed to capture the effects of the site or socio-economic characteristics, it is possible that they only partially manage that.

Predicting values: Applying OLS

Because we have no data on several variables that could explain the value, such as beach width and length or respondents' income, Ordinary Least Squares estimation of the linear model proposed by Brouwer (2001, stated above) will be biased. This is a standard result in OLS: missing regressors lead to bias unless there is no correlation between the missing variables and the included one (which is not normally the case). The panel data model presented above solves this problem with the introduction of the site-specific constants. This is the reason why we prefer the panel data model for the estimation of the effect of a variable on the value.

When the goal of the study is prediction however, bias in the estimated coefficients is not the main issue. Instead, we will focus on how well the model predicts the value. For that reason, we have estimated Brouwer's linear model using OLS. The results are reported here, but we do not comment on the estimated coefficients for the reason mentioned above.

Table IV.4

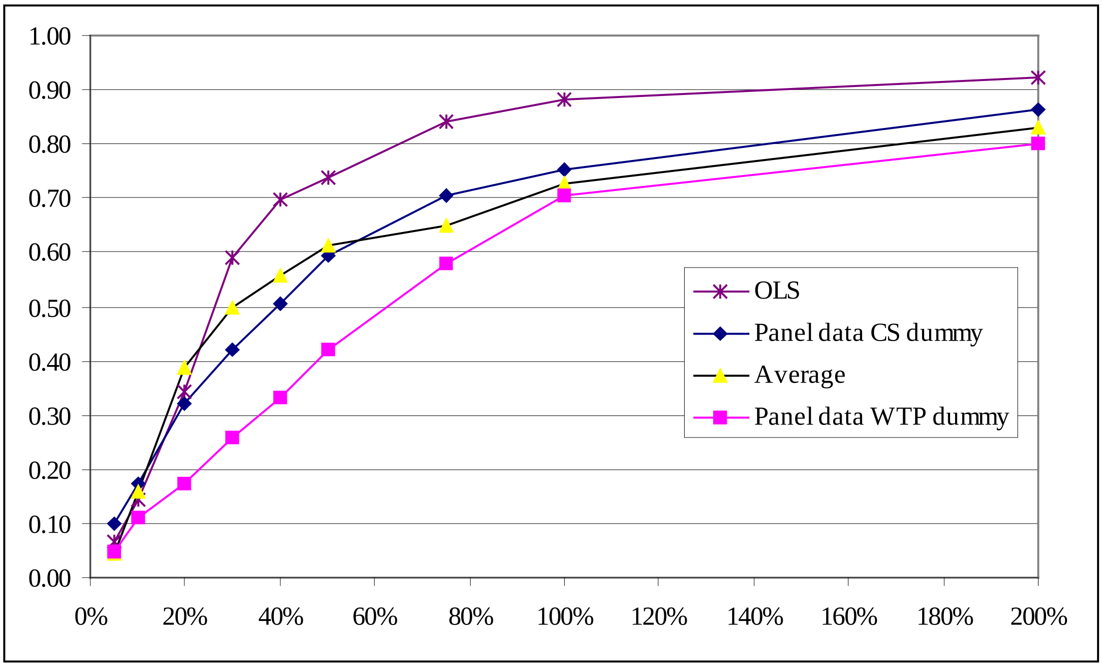
Variable	Coefficient	P-Value
Constant	-9.35	0.22
U.S.	23.56	0.11
NL	1.39	0.94
BEACH	-10.94	0.32
DUNE	-10.47	0.51
T	1.87	0.00
DAY	-7.82	0.14
LOCAL	-9.78	0.06
STAY	-8.00	0.13
WTP	-22.66	0.08
CS	-12.44	0.42
ERODED	-9.27	0.04
Unspecified defence	2.95	0.53
Defended by nourishment	-1.47	0.85
Defended by nourishment plus groynes	3.13	0.69

Transferring values: What do we loose?

We will now develop a transfer exercise on the basis of the regressions above. The goal is to measure the gain of precision obtained by carrying a new study. For that purpose, for each site, we run the above regressions (the 2 panel data regressions and the OLS) without this site's observation(s) and predict its value using the level of the regressors specific to this site. Then, we compare the predicted value with the one obtained from the original study. We also present the simple value transfer prediction which consists in predicting for one site the average value of the other sites.

Our measure of prediction error is the proportion of deviation from the value(s) reported for the site in absolute term. The formula used is | reported value – predicted value | / reported value. The results are presented in the following graph.

Graph IV.1. Benefit transfer cumulative distribution of prediction errors



The graph reports the proportion (vertical axis) of predictions that falls below the error level indicated on the horizontal axis. We call that the cumulative distribution of prediction errors. For example, the proportion of predictions of less than a 40% error is about 70% for OLS, 55% when the prediction is the average of the values of the other sites, 50% for the panel data model using the Consumer Surplus dummy (Table IV.2), and 35% for the panel data model using the WTP dummy (Table IV.3).

We say that model A predicts better than model B when the cumulative distribution of prediction errors of model A is above that of model B. In that sense, the panel data models are worse than a simple average of values (but that does not undermine their qualities for an unbiased estimation of regression coefficients). For prediction purposes, our best model is the OLS.

The next question is whether these results can be used in other sites. The answer is of course qualitative since there is no data to test this hypothesis, but again, the opinion of the leading experts in this field is that it isn't. One must take into account that an important part of the sample (about three quarters) comes from the relatively homogenous group of VOE values from the UK; it is homogenous not only because the studies follow the same protocols, but also because the population of visitors and the site characteristics are probably rather similar across sites (although we do not have hard data on that point).

VI. Conclusions

Using the literature, we have shown that there was a wide variety of benefits from coastal defence. Every site may be very different and generate qualitatively very different benefits. There is scarce empirical evidence on each type of benefit, the question of transferring benefits from the existing evidence to a new site seems therefore arduous. Professors Michael Hanemann and Colin Green, both leading world experts on the valuation of coastal assets, consider that it is a perilous exercise. However, they provided us with a limited set of data on informal beach recreation.

Pooling their evidence with that of the literature, we have arrived at some interesting evidence. First, the quality of the beach obviously matters for valuation. Second, it is possible that differences in value are due to differences in the method used, but the evidence at this stage is uncertain. Therefore transfer of benefits is unwise until more data is available and more consensus is reached on the appropriate valuation method. This concords with the evidence in other sectors, for example, the valuation of landscape conservation (Santos, 1999).

In the table below, we present the average of the available data on informal beach recreation and compare it with the US and UK recommended values, and with Loomis and Crespi (1999).

Table V.1. Value per visit to a generic beach (□ 2001)

Source	Country	Current state	Eroded	Defended
Average of data available for this report	UK	17.7	9.1	20.6
	US	23.1	-	-
	NL	1.7	-	-
Yellow manual (1992)	UK	15.6	8.2	18.7
NOAA (1995)	US	13.9	-	-
Loomis and Crespi (1999)	US	22.4	-	-

Our average is lower than that of Loomis and Crespi, while higher than "official" values. Professor Michael Hanemann already argued that the NOAA estimates were too low, at least for the Florida beaches. Globally however, the values are of the same order of magnitude, and in that sense we may have some confidence when transferring these benefits. The exception is the Dutch data with an average about 10 times lower than the UK average. This difference may however be due to a wide variety of factors including the sites characteristics and the valuation method. This is what the panel data intend to capture, we should not deduct that the Dutch values for the coast is in general substantially lower than in other countries.

Professor Colin Green's opinion is that, even though he does not recommend the use of benefit transfer for coastal values in general, the error that we will commit when counting the number of visits is certainly much higher than the error we may commit by transferring these generic values for informal recreation.

As mentioned in section III, there is little evidence on other classes of benefits. Bird viewing is estimated by Loomis and Crespi at 41.2 □ 2001 per day of visit, but this is based on US data only and it is difficult to imagine how it would transfer to a European context.

Land and building values are not the object of transfer in the literature. Both land and building rental prices are expected to drop to zero through a writing off process in an efficient market, with the zero value reached at the moment the land or building is lost to sea (see in annex II the summary of Yohe, Neumann and Marshall's approach, 1999, for a more detailed description). The value of a protection scheme in this context is the discounted flow of rental prices that is gained with protection comparatively to the flow without defence. Heritage building do not follow this rule because they are not substitutable, but no evidence exists in the literature.

Regarding non use values, Professor Collin Green considers that their estimation is conflictive and that their transfer should not be attempted. Instead a specific study is recommended when there is a presumption that they may be large.

Regarding the other classes of value as indicated in tables 1 to 5 of section III, the existing evidence is too specific to be transferable, or there is no evidence.

In the context of the DELOS project, how interesting are these results? If the purpose of the benefit transfer work package was to find differences in value between different types of Low Crested Structures (LCS), we have found out that neither the experts in the field nor the literature can provide enough information. The only piece of data that we have on that aspect refers to a site called Lee-on-Solent in the UK where the respondents were asked to value (using VOE) the beach in 2 hypothetical states of defence. Defence A consisted of nourishment only, defence B, of nourishment plus groynes (there is no more detailed information). It seems that groynes are in fact valuable for the locals. The VOE for this site are reported in the following table.

Table V.2. VOE for Lee-on-Solent (in 2001 □) per visit

	State of the beach			
Visitors	Current	Eroded	Defence A	Defence B
Local	16.8	11.8	18.9	33.7
Day	15.3	11.8	17.3	17.3
Stay	21.5	15.4	23.6	22.7
Average	16.6	12.1	18.6	18.6

Source: C. Green and own calculations

Apart from that single observation, we are not aware of other evidence about differences in value for different LCS.

VI. References

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VII. Annexes

Annex I. The data file used for the regressions on informal beach recreation

The table below is an Excel file, by double clicking it, the whole file is accessible.

Ref	study	i	Country	site type	T	Date	Respondents	E2001	ValType	SiteQual	Valuatic
1	Bridlington	1	UK	Unknown	15	1989	All	15.50	VOE	Current	Open-e
2	Clacton	2	UK	Coastal site	14	1988	All	27.04	VOE	Current	Open-e
3	Clacton	2	UK	Coastal site	15	1989	All	27.23	VOE	Current	Open-e
4	Cliftonville	3	UK	Unknown	19	1993	All	14.30	VOE	Current	Open-e
5	Dunwich	4	UK	Coastal site	14	1988	All	18.65	VOE	Current	Open-e
6	Dunwich	4	UK	Coastal site	15	1989	All	29.64	VOE	Current	Open-e
7	Eastbourne	5	UK	Coastal site	19	1993	All	3.55	WTP for use	Current	Open-e
11	Filey	7	UK	Coastal site	14	1988	All	9.67	VOE	Current	Open-e
12	Filey	7	UK	Coastal site	15	1989	All	21.92	VOE	Current	Open-e
13	Frinton	8	UK	Coastal site	14	1988	All	25.85	VOE	Current	Open-e
14	Frinton	8	UK	Coastal site	15	1989	All	14.52	VOE	Current	Open-e
15	Hastings	9	UK	Coastal site	14	1988	All	20.96	VOE	Current	Open-e
16	Hengistbury Head	10	UK	Coastal site	22	1996	All	17.50	VOE	Current	Open-e
17	Hengistbury Head	10	UK	Coastal site	22	1996	All	17.62	VOE	Defended	Open-e
18	Hengistbury Head	10	UK	Coastal site	22	1996	All	12.28	VOE	Eroded	Open-e
19	Hengistbury Head	10	UK	Coastal site	22	1996	Day	20.51	VOE	Current	Open-e
20	Hengistbury Head	10	UK	Coastal site	22	1996	Day	16.06	VOE	Eroded	Open-e
21	Hengistbury Head	10	UK	Coastal site	22	1996	Local	15.09	VOE	Current	Open-e
22	Hengistbury Head	10	UK	Coastal site	22	1996	Local	9.03	VOE	Eroded	Open-e
23	Hengistbury Head	10	UK	Coastal site	22	1996	Stay	18.78	VOE	Current	Open-e
24	Hengistbury Head	10	UK	Coastal site	22	1996	Stay	13.93	VOE	Eroded	Open-e
25	Herne Bay	11	UK	Coastal site	16	1990	Local	8.62	VOE	Current	Open-e
27	Hunstanton	12	UK	Unknown	15	1989	All	21.92	VOE	Current	Open-e
28	Hurst Spit	13	UK	Coastal site	17	1991	All	16.16	VOE	Current	Open-e
29	Hurst Spit	13	UK	Coastal site	17	1991	All	6.07	VOE	Eroded	Open-e
30	Hurst Spit	13	UK	Coastal site	17	1991	All	22.32	VOE	Defended	Open-e
31	Hurst Spit	13	UK	Coastal site	17	1991	Day	15.98	VOE	Current	Open-e
32	Hurst Spit	13	UK	Coastal site	17	1991	Day	5.94	VOE	Eroded	Open-e
33	Hurst Spit	13	UK	Coastal site	17	1991	Day	30.68	VOE	Defended	Open-e
34	Hurst Spit	13	UK	Coastal site	17	1991	Local	19.43	VOE	Current	Open-e
35	Hurst Spit	13	UK	Coastal site	17	1991	Local	4.85	VOE	Eroded	Open-e

Annex II. Summary of previous benefit transfer studies relating to coastal defence

<u>Indicative recreational coastal values:</u> Loomis and Crespi (1999) are primarily interested in estimating the effects of climate change on 41 outdoor recreational activities in the US, 3 of which take place in coastal areas and have sufficient data. Their methodology essentially consists in finding an estimate for a daily average value for a given activity, and an estimate of the change in the number of visitor days for some scenarios of climate change over the whole US. This is deemed to understate gains and overstate losses. Their data sources for the coastal activities are documented in their paper. Their basic scenario is + 2.5 º C and + 7% precipitation, corresponding to a doubling of CO2 impacts expected for 2060.

Table: Current (baseline) coastal activities in Loomis and Crespi (1999)

Activity	Visitors days (Millions)	Value per day (1992$)	Climate Elasticity (see below)
Coastal waterfowl hunting	16	30.45	0.275 Coastal wetlands
Coastal bird viewing	169	29.91	0.173 Coastal wetlands
Beach visitation	192	16.30	1.6 to 2.1 Temperature –0.008 to –0.41 Rainfall +0.09 to 0.43 Shoreline

Beach visitation. They estimated the following regressions per region: ln (visits) =

.302 + 1.903 ln (temp) - .414 ln (rain) + 1.15 Summer + .425 meter in North-eastern US

2.89 + 1.618 ln (temp) - .307 ln (rain) + .469 Summer + .096 meter in Southern US

1.53 + 2.126 ln (temp) - .0085 ln (rain) + .1145 Summer + .147 meter in Western US

where *visits* is total number of activity days per month, *temp* is average daily temperature, *rain* is inches of rainfall during the month, *summer* indicates summer holidays months, and *meter* is the length of the beach in meter (public beaches included in the NOAA survey only). The t-statistics and R-squared can be found in the reference. The regressions are used to predict changes in recreation under 2 scenarios for the meter variable (for +2.5º C + 7% rain). The 1st scenario is that no beach will be lost (because beach nourishment is technically- and cost-effective for +2.5º C + 7% precipitation following Yohe et al., 1999, and Leatherman, 1989, and where it is not protected the beach moves inland). The 2nd scenario is that 16% of the beach will be lost (Fankhauser, 1995).

Coastal waterfowl hunting: The elasticity in the table results from computation from documented secondary results, a 1% change in wetland acres results in a .275% change in hunter days. Changes in wetland acreage due to climate change induced sea level rise are documented in Smith and Tirpak (1989).

Coastal bird viewing: Using documented primary data, a regression is estimated resulting in a prediction of a change in .173% bird viewing trips for a change of 1% in the number of birds seen per trip. To link that result to sea level rise, it is assumed that a reduction of 1% of wetland area results in an equal reduction of bird population, which in turn results in an equal reduction of birds seen per trip.

Using these estimates, Loomis and Crespi (1999) can estimate the change in days for their central +2.5º C + 7% precipitation as in the following table, for maintained 1990 use levels and for predicted 2060 use levels. Sensitivity analysis indicates robustness for beach recreation (not performed for the other activities). This analysis is just gross benefits and does not take adjustment costs (e.g. beach nourishment) into account. Other limitations of the results are indicated.

Activity	Year	Visitors days (Millions)			Change in economic value (1992$)
		No climate change	+ 2.5º C +7% rain	Change in days	
Waterfowl hunting	1990	15.96	15.76	-0.20	-5.80
	2060	19.08	18.85	-0.23	-6.94
Bird viewing	1990	169.34	169.26	-0.08	-2.26
	2060	277.03	276.88	-0.15	-3.77
Beach visitation	1990	191.70	218.65	26.95	+337.90
	2060	256.10	292.15	36.05	+451.48

Indicative values for erosion cost (1st example): Yohe, Neumann and Marshall (1999) are interested in damage to coastal properties. There are 3 scenarios of Sea Level Rise (SLR): 33 cm, 67 cm, and 1 m. SLR occurs following the equation $SLR(t) = b\ t^2$ where the value of b changes in each scenario, t is zero in 1990 and 110 in 2100. For a sample of 30 sites in the 4 US coastal regions, they forecast inundation patterns in 5-year increments until 2100 on 500 m x 500 m cells spatially explicit including natural land subsidence. Decision can be taken at any decade t0 (from 1990 to 2100) to protect such a cell until some decade T (abandonment). The decision is based on an adaptative CBA rule which represents a mixture of efficient public and private decisions. The CBA rule is the maximum discounted intertemporal welfare with benefits and costs described below.

Benefits of protection from t0 to T = true opportunity cost of abandoning the property = economic damage of future SLR if the property is not protected. They first need a satisfactory description of the evolution of real estate price as a function of future development in the absence of threat, this is given by $d[\ln(P_t)] = \alpha_0 + \beta_L g_L + \beta_Y g_Y + \beta_{-1} d[\ln(P_{t-1})]$ where P_t is the real price at t, g_L is the population growth rate, and g_Y is the per capita income growth rate. The symbol *d* is left unexplained but probably indicates a growth rate. This equation is estimated for each of the 30 sites in the sample and it is valid both for coastal land and coastal structures (i.e. properties). When the threat becomes real, the evolution of values is different for land and for structures and changes in each cell.

Land values continue to follow the equation and drop to zero when inundation occurs (time T), however the lost value is the value of land located inland because the premium for coastal land shifts inland (exception are coastal barriers and possibly wetlands, but they do not explain whether they take that into account). Structures values start depreciating 30 years before inundation in an efficient market and reach zero at T at which time they are abandoned (True Economic Depreciation, 30 years is the lifespan of a structure from the point of view of the US IRS). This is a scenario of perfect foresight. If the market is not efficient or if abandonment is uncertain then the market has less than 30 years to react and properties do not have a value of zero at time of abandonment, they investigate a scenario of no foresight at all, as if SLR would occur instantly. In this case, the equation applies until T.

Costs of protection from t0 to T is the time trajectory of protection costs. The costs of protecting structures is assumed to be $750 per linear foot for a generic hard defence (called fixed or structure cost) + 4% per year maintenance cost (variable cost) or 10% per year if the site is on the open ocean. These costs are different in their 3 scenarios and increase geometrically with SLR, this is represented by: cost for 1m SLR = 2 x cost for .67 m SLR = 4 x cost for .33 SLR. They do not say for what scenario their baseline costs apply. The cost of protecting beaches is the cost of nourishment (based on amount needed and local price of sand) if SLR is no bigger than .33 m and if protection starts at t0 (for some sites, protection should have been started before 1990, when it did not, then protection did not start at t0). When SLR is larger than .33 m, a hard defence is built at the back of the beach with maintenance 10% per year (open ocean).

The discounted sum of costs and benefits are then computed for each site (after estimating the inundation pattern) until 2100, and decision is taken to protect in some year on a cell-by-cell basis. The 3-pages long table 7.9 presents the results for each site for each SLR scenario with perfect and no foresight and the decision to protect or not (sensitivity analysis is also done for protection costs). This table is summarised in table 7.10 reproduced below (millions of 1990$, 3% discount rate):

Scenario	Present value	Annuitized annual cost	Transient cost in 2065	Percent protected
1 m, perfect foresight	5 465	164	333	40
1 m, no foresight	6 440	193	384	70
.67 m, perfect	2 802	84	170	60
.67 m, no	2 988	90	195	78
.33 m, perfect	895	27	57	88
.33 m, no	930	28	57	96

Transient costs are actual costs incurred in the year indicated. The small cost increase for no foresight is easily explained: 1. a lot of properties are protected under perfect foresight, so improved information is not much valuable; 2. because of the pace of SLR (rising with time squared), a lot of the properties are protected only in the distant future, thus the cost is very much discounted. Their results are the lowest in the literature, by a factor of about 10, because earlier estimates had higher SLR and/or no adaptation (i.e. market depreciation). It is noted that storms or other stochastic events, and distributional issues are not taken into account. They recognise that their model is quite data intensive and maybe difficult to use outside the US.

The trajectory for SLR maybe one key assumption of their model: it causes most of the inundation to occur in the far future, thus their costs are discounted, if the trajectory was more linear (instead of quadratic) more damage would occur sooner and their estimates would be higher. They do not analyse the sensitivity to this assumption. Even though this is not explicit, they consider all kind of lands, including undeveloped lands and wetlands, in their approach since they use market data on a sample of regions. They do not specify how the sample was taken nor how they estimated values for wetlands.

Indicative values for erosion cost (2nd example): **Fankhauser (1995)** builds a general model of adaptation to SLR. He recognises that optimal coast protection is a regional problem because of the regional specificity of the coastline, but he does a top down approximation. His model is built on a CBA rule: adaptation should take place as long as benefits from avoided damage (caused by land loss in his model) is larger than the incremental cost of additional action.

Since Fankhauser’s work is set primarily in a context of climate change, he first presents a result linking protection to greenhouse effect: A 2-step process in which decisions on adaptation are taken locally while optimal abatement level is taken globally is equivalent to simultaneous optimisation provided that the global warming damage is specified as the cost minimising combination of adaptation plus cost of damage. From here on, we can focus on protection alone.

Optimal SLR protection

Fankhauser makes the following simplifications: 1. the two available SLR responses are retreat or protect (no accomodate as in the IPCC reports), 2. a single protection measure is available per region (actually a one time decision to protect a percentage of the region coast by a sea wall), 3. there is only 2 kinds of coasts, dryland and wetland (wetland is saltwater marshes), 4. there is no saltwater intrusion, 5. there is no storm and flood damage costs, 6. there is no added pressure on the natural environment, 7. the amount of SLR is known with certainty, 8. defence is built as SLR increases, 9. dryland is protected highest value first (thus the average value of lost dryland depends on how much has been protected), 10. wetlands cannot be protected but can migrate inland if there is no seawall, else they are lost to sea (wetland loss is inversely proportional to defence and increases with the speed of SLR).

Thus for each region (an OECD country in Fankhauser's empirical analysis), the costs of SLR = cost of protection + dryland loss + wetland loss, and we seek to minimise the discounted sum of these 3 streams. The control variables are the percentage of dryland protected and the height of the protection. Since defence is built as SLR rise, the optimal height is equal to SLR in each period. The optimal percentage of coast protected can be shown to be

$L^* = 1 - \frac{PC^{pv} + WG^{pv}}{2DL^{pv}}$, or zero in case the formula would return a negative

The new notation is pv for present value, PC for protection cost, WG for wetland gain (sum of the amount taken away by the sea minus inland migration), DL for dryland loss. Derivating L^* with respect to SLR yields the change in optimal percentage of protected coast for a change in SLR, it has an ambiguous sign because on the one hand more protection is needed when SLR increases, but it is also more costly, so this will depend on regional particulars. Finally, the previous derivative allows Fankhauser to express costs as a function of SLR.

Simulation for OECD countries

Data sources are mostly IPCC (1990), but also Titus et al. (1991) and Rijsberman (1991), and are sometimes extrapolated. IPCC distinguishes 4 types of coasts: cities, harbours, beaches and open coasts. Wetland are assumed to occur on open coasts only, beaches are protected by beach nourishment, the rest is protected by sea dikes. The length of each type of coast is given in a table. Average land value is set to \$2 m/km2 for open coasts and beaches, \$5 m/km2 for wetlands, \$200 m/km2 for cities and harbours (somewhat lower for the former USSR and China). Fankhauser claims that his figures have low reliability and then provides optimal percentage of protection per type of coast for levels of SLR in year 2100 from .2 m to 2m. On average for the OECD, nearly 100% of cities and harbours are protected, about 80% of open coasts and 50 to 60% of beaches, but there are wide variations across countries. The bulk of damages comes from wetland loss (about 80%), followed by protection costs; dryland loss is negligible. For a 1m SLR by 2100, the cost is $425 bn for the US, $22.4 bn for The Netherlands, and $45.3 for Italy. Damages looks roughly proportional to the length of coast. There is important sensitivity to land values, especially wetland, to SLR pace, and to discount rate.

These three benefit transfer exercises (Loomis and Crespi (1999), Yohe, Neumann and Marshall (1999), Fankhauser (1995)) seem carefully done, and relatively well documented (except in the case of Yohe, Neumann and Marshall (1999)). There is however no confidence intervals on their predictions but only a rather arbitrary sensitivity analysis and some comparisons with the literature. In essence, all three are crude benefit (value) transfer exercises because they base their estimates on intuitive/arbitrary averages of sites values, without specifying where these values come from, and transfer these values to sites with potentially very different characteristics, population, and policy options.