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Assessing socio-economic impacts of wave overtopping: An institutional perspective

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ABSTRACT

One way to address the assessment of strategies to control wave overtopping at seawalls and related coastal defence structures is to make use of Cost-Benefit Analysis. The institutional context in which Cost-Benefit Analysis takes place influences decisions on the types of values that are taken into consideration and the subsequent selection of valuation methods. We suggest to consider Cost-Benefit Analysis in a broad institutional framework when decisions are to be made on coastal defence strategies. It is argued that the institutional context provides the rules of the game on how a balance can be found between social, economic and ecologic functions of projects that protect societies against overtopping.

1. Introduction

Overtopping occurs when waves run up the beach, revetment, seawall or breakwater and pass over the crest of the defence. The resulting flow is often termed 'green water' overtopping. The frequencies, volumes and velocities of these overtopping events substantially influence the safety of the defence and of people living, working or travelling close behind the defence structure. A second form of overtopping occurs when waves break on or seaward of the face of the structure and produce significant volumes of fine droplets. The major hazard related to this 'spray overtopping' is reducing visibility on coastal highways where the sudden loss of visibility may cause significant driving hazard (Allsop et al., 2003).

The possible damage of a wave overtopping event depends on a large number of factors: the timing and intensity of the event, the presence of human settlements in the affected area, the income characteristics of the population, the amount of traffic, the presence and value of private property and companies, the level of investment in other infrastructure, the type of activities taking place, etc.

Allsop (2004) identifies three types of hazards from direct wave and overtopping effects, namely

- direct hazard to people (injury or death);
- damage to property, operation and/or infrastructure in the area. The disruption of economic activities falls under this category;
- damage to defence structures.

The latter category may lead to failure of the defence, which in turn might cause flooding and thus also e.g. hazard to people or damage to property and infrastructure.

Various measures can be taken to mitigate the effects of wave overtopping. Unless otherwise specified, we will use the term coastal defence to identify structures that protect against wave overtopping effects. Pettit (1999) uses the term as a generic name that includes coastal protection (protection of the land from erosion and subsequent inundation), sea defence (protection of land from flooding) and tidal defence (sea defence upstream of a specified boundary). It includes all forms of structural (engineering for flood defence/erosion protection) and non-structural (development planning in coastal areas) methods of protection from tidal erosion and inundation.

Economic appraisal enables the comparison of differing options in order to identify those which provide overall best value for money. In the context of flood and coastal defence projects, Cost-Benefit Analysis (CBA) will normally be a significant factor on which schemes and scheme options will be selected (MAFF, 2001). One of the prerequisites for sound Cost-Benefit Analysis is the existence of adequate valuation techniques, so that significant but unpriced effects can be included. Many studies have been carried out to identify the effects of flooding and value them in monetary terms. The socio-economic impacts of wave overtopping are less documented from a valuation perspective. The development of valuation techniques goes hand in hand with the increasing use of Cost-Benefit Analysis. Decisions on

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large infrastructure projects for example, are often preceded by CBA. Whereas in the past CBA mainly acknowledged effects that could relatively easily be expressed in monetary values because one could appeal to market prices, the current trend is to incorporate costs and benefits for which the monetary valuation is less straightforward. An overview of the use of CBA in water management in the Netherlands shows increasing relevance of the inclusion of ecologic and social dimensions of water management (see www.mkbainderegio.nl). This growing need to assess costs and benefits that are less straightforward increases the relevance of the informal and formal rules on how to proceed with the process of valuation.

Monetary valuation of costs and benefits is a prerequisite for using Cost-Benefit Analysis to decide on investments that mitigate the impacts of wave overtopping. In the next section, we highlight the possible interaction between the concept of risk and the outcome of assessment methods that rely on monetary valuation. We then focus on the role of decision-makers and the importance of the institutional context when using valuation methods. Our ideas are illustrated in the fourth section, by looking into the costs that occurred in the port of Rapallo (Italy) during the storm of November 6th 2000 and referring to a beach nourishment project that was carried out in De Haan (Belgium).

2. Valuation and the concept of risk

A central concept in the valuation approach with respect to flooding/overtopping is the notion of risk, which is commonly defined as the probability of an event occurring multiplied by the damage caused by the event. The probability of occurrence of an event can reduce the appropriateness of several valuation techniques. Indeed, the evidence suggests that e.g. the timing of a valuation study vis-à-vis the latest flood influences its outcome (Shabman and Stephenson, 1996). Furthermore, a prerequisite for the use of some valuation methods is the fact that governments and individuals need to be aware of the probability of occurrence of an event. For a further elaboration of these considerations, we refer to Bouma et al. (2005).

The major risk related to wave overtopping is the risk to human life. Overtopping involves the risk of being swept away by the water and possibly getting drowned. Economic valuation of 'human life' is a heavily debated issue in economic literature. Despite this controversy, several methods to value human life, or to determine the value of a 'statistical life', have been developed. Table 1 gives some examples of these methods (based on Mishan, 1975; Landefeld and Seskin, 1982; Viscusi, 1993).

The decision to include the value of human life into a CBA and the way in which one calculates these values is certainly not straightforward. An additional difficulty concerns the way in which one determines how many people can be considered to be 'at risk'. Several methods have been developed for this purpose. Penning-Rowsell et al. (2005) present a framework for assessing and mapping the risk of death or serious harm to people from flooding. Based on Bottelbergs (2000) and Laheij et al. (2000), Table 2 briefly introduces some of the relevant concepts when estimating the number of people at risk. Such estimation is not necessarily linked to valuation studies and Cost-Benefit Analysis. Risk assessment is however a necessary condition to include values of statistical human lives in CBA.

Table 1
Valuing human life

Method	Description	Remarks
Human capital method: gross human capital approach	Discounted future earnings	Measures possible future production; no estimation of intangibles
Human capital method: net human capital approach	Discounted value of the losses over time accruing to others only	Takes into account the fact that a person's claim on future consumption is also lost; no estimation of intangibles
Stated preference methods: contingent valuation method	Uses questionnaire to discover people's willingness to pay for a reduction of the risk of death	
Revealed preference methods: wage differential approach	Based on difference in wage for jobs with a difference in risk of death	Based on the assumption that a higher level of risk is compensated by a higher wage; if information is incomplete, wage premiums may not accurately reflect workers risk preferences

Table 2
Individual risk, societal risk, population at risk, potential loss of life

Method	Description	Remarks
Individual risk (IR)	Probability that an average unprotected person, permanently present at a certain location, is killed due to an accident resulting from a hazardous activity	Cannot be used to value injuries; depends on the geographic situation (thus not characteristic for any person but for the location for which it is calculated)
Societal risk	The probability that a group of more than N persons would get killed due to an accident at a hazardous activity	Not dependent on the location but characteristic for the hazardous activity in combination with its populated surroundings
Population at risk (PAR)	The population that is directly threatened by a hazard	Gives an impression of the magnitude of the disaster; possible injuries can be incorporated; absence of a probability
Potential loss of life (PLL)	The expected value of the number of deaths per year	Can be calculated from the individual and societal risk

If there is an agreement to impute a monetary value on the vulnerability of human (statistical) lives when assessing coastal defence projects, the outcome will thus not only depend on the valuation method used, but also on the number of people that are considered to be 'at risk'. The latter decision puts the concept of exposure at the centre of the appraisal. Exposure can be defined as the amount of people who are at the potential hazardous place at the moment of overtopping. It depends on the time of day, the season, warning signs to alert people, the sightseeing value of the hazardous site, the possibility to deny people the access to coastal defence structures at dangerous times,… Exposure potential is also related to the "suddenness" of flooding (Penning-Rowsell et al., 2005), which is a very important factor in the case of overtopping. The methods described in Table 2 express the risk to human life in very different ways. If no people are present at the time of overtopping, there is no societal risk whereas individual risk need not be nil. The individual risk stays the same whether people are present or not.

Exposure is influenced by the awareness of the dangers of wave overtopping. People might not be fully aware of these dangers and rely on an illusory feeling of absolute safety. By increasing awareness, authorities should be able to reduce exposure and thus the 'human costs' related to wave overtopping. A particular problem related to wave overtopping is the occurrence of thrill seeking attitude. Such behaviour makes it very difficult to fully eliminate exposure. The effectiveness of information campaigns and warning signs to enhance awareness and reduce exposure thus depends to a large extent on the risk attitude of individuals. News coverage on storms in coastal regions too often reflects the ambiguous role of the media with this respect.

3. Assessing impacts of wave overtopping: the role of institutions

3.1. Valuation as a process: the role of the decision-maker

Valuation is increasingly used when making investment decisions with respect to coastal defence schemes. If flood damages can be valued in monetary terms, an answer can be provided to the question how the costs related to reducing these impacts compare to the value of the reduction in damage related to flooding. Valuation is however a contentious subject, especially when environmental issues are involved. With respect to this debate, Baarsma and Lambooy (2005) point out that valuation methods are not about measuring the value of environmental goods, but about measuring the preference for environmental goods to sustain the decision-making process.

Within the extensive valuation literature, the valuation of effects of flooding events is well documented. Specific research into the valuation of effects of wave overtopping however, seems to be very limited. From a valuation point of view, a number of key features are common to the effects of flooding. However, the hazards of wave overtopping alone are more local, but may be more damaging, especially when hazards to people are concerned.

Some effects can relatively easily be expressed in monetary terms, others however are less tangible. Especially the decision on whether or not to include the valuation of human lives can be controversial. Based on micro-economic theory of utility and preferences, different valuation methods have been developed to estimate the value of resources. Valuation methods have become increasingly sophisticated and complex. Special valuation techniques exist for those cases where effects can not be readily expressed in monetary terms, because, for instance, market prices for specific goods or services are not available. For an overview of the most commonly used valuation methodologies we refer to, among other, Turner et al. (2001). Each method has its advantages and disadvantages, depending on what has to be measured. Usually, a combination of methods is required.

Valuation is more than the mere monetary expression of costs and benefits. Valuation is a process, and it should start with clarifying the perspective of the decision-maker. One of the differences among decision-makers may be related to the types of values they want to consider. These considerations are embedded in both formal and informal rules. For example, formal rules may express the need to consider certain ecological effects in a CBA (valuation of ecosystems). Informal rules are often culturally bound and may express what good ecological quality may encompass: what reference values are to be used to define the natural state of an ecosystem?

As not all valuation methods can be applied to each category of effects, the inclusion of some effect into an assessment puts its limits on the selection of techniques to monetize effects. The properties of the site under study often determine which method is most capable of giving representative results. It is also important to keep the drawbacks of each method in mind and to be aware of the fact that the underlying assumptions on which the methods are based can show significant differences. According to Shabman and Stephenson (1996), one criterion to judge valuation techniques for public-decision making is by choosing the technique that best facilitates collective choices. Only when reasonable consensus and confidence develops among decision-makers, will the technique play a significant role in collective choice.

When a CBA is used to evaluate coastal defence projects, results of the process of valuation should be fully recognised by the decision-makers. A number of conditions should be met when measures are to be evaluated. These conditions are:

1. While applying the valuation concept it should be clear what effects should be considered (monitoring condition). Within this condition, data availability plays an important role;
2. Modelling techniques to predict the impacts of measures should be available (modelling condition);
3. The economic values should be comprehensible and acknowledged by the decision decision-makers (conditions of applicability and acceptance). This third condition is of particular importance when e.g. the value of ecosystem services or human health is to be taken into account.

Some recent policy shifts can be observed with respect to flood management in general and consequently with respect to the way in which the problem of overtopping is approached. Current policies increasingly incorporate notions such as 'live with floods' and 'make space for water' (Johnson et al., 2007). On the other hand there is still a tendency to concentrate tangible as well as intangible assets in areas that are prone to flooding and/or overtopping. This tendency leads to increasing potential damages, which in turn might strengthen the focus of decision-makers on economic considerations (Johnson et al., 2007).

The purpose of a Cost-Benefit Analysis is to inform decision-makers on the costs and benefits related to a project. When a CBA is performed, decision-makers implicitly shape the valuation process. The influence of the decision-makers can however also be more explicit, as the final decision on whether or not to engage in the project lies in their hands. Policy makers can decide to carry out a project with a net cost or to abandon a project with net benefits.

3.2. Assessing wave overtopping: towards an institutional perspective

The methods that have been developed to value environmental effects originate from the neoclassic economic approach. But is this the most appropriate perspective on which to base decisions related to the level of coastal protection? Why would an approach that solely rests on neoclassical assumptions be insufficient when environmental concerns are at stake? Baarsma and Lambooy (2005) question the assumption of consumer sovereignty when dealing with choices that relate to complex environmental issues. Also, preferences may sometimes be constructed during the valuation process instead of being given. We already referred to the concerns with respect to valuing effects with low probabilities of occurrence. Other concerns regard for example the convexity of preferences (Baarsma and Lambooy, 2005).

The institutional context in which valuation takes place influences the assessment of coastal defence schemes in various ways. We have already emphasized the fact that decision-makers have a significant input into the valuation process, for example with respect to the choice of effects they deem necessary to be valued or the scope of these effects. To a large extent, decision-makers will be steered by the context within which they operate. In a pure private-sector context, the only costs and benefits that are relevant are those where the decision-maker is directly involved. In a societal context, this is no longer the case. By including the impact of measures on e.g. employment, tourism, landscape, the environment or human health, governments tend to apply a social cost-benefit criterion, for which a number of valuation methods can be used. However, they may sometimes use the more financially oriented concepts in the case of their budget control. The specific institutional context needs to be assessed to understand which value concepts are applicable. Crucial in this respect is how the policy goals related to sustainable development are operationalized: which functions of what ecosystems need to be included, how to incorporate the unknown preferences of future generations and how to acknowledge the effects of the ongoing climate changes?

A second choice that is influenced by its context concerns the use of valuation methods. It is obvious that there is no ideal valuation technique, or combination of techniques. Substantial differences in approaches exist. The choice of technique also depends on the objective of the valuation. If attention-raising is the goal, results from other studies can be transferred to obtain order of magnitude estimates (Benefit Transfer). However, if more accurate damage valuations are required for purposes of including them in a scientific model, other techniques must be used, which allow more precise estimates.

Decision-makers are also required to make a choice on the appropriate discount rate and the project life of the proposed scheme. This choice has a profound influence on the outcome of the study as future costs and benefits will have smaller present values the higher the discount rate or the further they are situated in the future. Defining the appropriate discount rate is not straightforward and no firm conclusions can be drawn on which rate should be used. Different effects of a project may be associated with different assumptions. Some of these can be established in formal rules. For example, Dutch water managers need to apply discount rate of 3% in a CBA (see www.mkbainderegio.nl). Once again, the distinction between the social or private cost-benefit concept proves to be of importance.

The neoclassic approach is not the only relevant approach when it comes to analyse environmental problems through an economic lens. Institutional economics has provided essential insights that add greatly to the management of environmental problems. Vatn (2005) distinguishes three positions within institutional economics. A first distinction that is made is that between 'classical' and 'new' institutional economics. The third view is that of 'instititutions-as-equilibria'. A further elaboration of these different positions is beyond the scope of this article, but is important to note that in institutional economics, the notion of value is interpreted in a broader sense than the monetary understanding common to the neoclassical economic approach.

Vatn (2005) bases his analysis on the insight that institutions influence individuals and their motivations. According to Vatn, who follows a classical institutional economics perspective, "various methods for assessing environmental goods influence which values can be expressed, how they can be expressed, and consequently which choices are found favourable" (Vatn, 2005).

The current safety levels offered by coastal defence schemes are the result of investment decisions that were taken in the past. This influences both the costs (related to increasing or maintaining safety levels) and benefits of coastal defence strategies. Policy priorities are however subject to change, and relying solely on Cost-Benefit Analysis as a tool to decide on the desirability of coastal defence projects might result in a biased view, in which the impact of previous decisions is often underestimated. Johnson et al. (2007) stress the need to change investment appraisal procedures, as the current appraisal process is unable to bridge the gap between current policy ideals in flood risk management and increasing potential economic damages. They call for an evolution from the current focus on schemes, which is dominated by economic damages, towards an approach in which risks are managed based on the economic, social and environmental pillars of sustainable development (Johnson et al., 2007).

What tools are better suited to assist decision decision-makers according to the institutional school? Baarsma and Lambooy (2005) refer to Coasian negotiations, multi-criteria analysis, allocation games and value juries. They also suggest the option to implement a politically determined set of rules, even if this implies that a clear base of measurement is lacking. Under this scenario, the strength of pressure groups becomes an important determinant of the outcome of the decision making process.

Although the views on valuation differ between neoclassical and institutional economists, Cost Cost-Benefit Analysis can serve a useful purpose according to both views. CBA is often used to evaluate large scale infrastructure projects. According to some institutional economists, the method is better suited to evaluate local, small and short term effects (Baarsma and Lambooy, 2005). Baarsma and Lambooy (2005) argue that the monetary approach and the new institutional perspective can be complementary, provided that the policy goal has already been established.

4. Wave overtopping: a case for Cost-Benefit Analysis?

Coastal defence schemes can take many forms. In this section, the port of Rapallo (Italy) and the sea resort of De Haan (Belgium) are the settings to illustrate our considerations with respect to the valuation of overtopping effects. In the port of Rapallo, the storm of November 6th 2000 caused extensive damage. At De Haan, a beach nourishment project was carried out after the coast was hit by a severe storm in 1990.

4.1. The port of Rapallo (North-Western Italy)

In the practically tideless Italian seas, most harbours are built on open coasts and are protected by breakwaters. Typically, these harbours provide berths along a quay wall at the rear side of the main breakwater behind a concrete crown wall. In many cases the design of the parapet wall crest is constrained by stringent visual impact criteria, which are strictly enforced. On November 6th 2000, a storm caused extensive damage to moored yachts and to harbour structures and utilities at the Marina Porto Sole in San Remo, Marina degli Aregai in Imperia and Marina Carlo Riva in Rapallo in the Liguria region. The events caused by the storms were rather exceptional and estimated to occur once every 70 years because of the wind direction and the long wave lengths. After this extreme weather event, the Italian government declared the state of emergency (Franco and Bellotti, 2003).

The port of Rapallo is mainly used for recreational purposes, and some small-scale fishing takes place. In many ways, the marina at Rapallo is representative of any of the aforementioned smaller ports. The port consists of two small basins, separated by a pier, one being the international port "Carlo Riva", the other one being the municipal port. The Carlo Riva port, being the one on the sea-side, is the most vulnerable to damage from wave overtopping events. The number of berths for Rapallo is around 900. The marina Carlo Riva is protected by a dam. About 500 m deeper into the bay there is an area where shops and restaurants are located. During wave overtopping events, these areas can be affected by damage from partial inundation of the quays.

Most direct damages on public and private property can be estimated using an approach based on market prices. Apart from the damage to the coastal defence, other types of damage were not sufficiently documented, so we had to rely on telephone interviews and assumptions had to be made. The restoration costs amounted to 2 197 468 Euro (La Barbera Srl, 2002). For estimating the restoration costs to private property, we assume that 5 yachts suffered damage for a total of 200 000 Euro, or 40 000 Euro per yacht. We can assume that a major part of this damage is covered by private insurance. We checked whether insurance premiums had gone up due to this event, but this does not seem to be the case.

Indirect damage of wave overtopping can consist of income loss for the marina's due to for example lower occupancy rate, damaged reputation for safety of the marina, possible landscape values affected by the damaged dams, the periods of reconstruction and the new coastal defences, etc. When estimating the production losses for the Marina assumptions had to be made with respect to the loss in the occupancy rate. We also assumed that damages were caused by wave overtopping itself and not by other associated phenomena like wind, flying debris, etc. Suppose for one year the occupancy of the marina diminishes by 10%. This would include reduced occupancy during restoration works. For a total of about 900 berths (399 at the Marina Carlos Riva and 500 at the Porto Communale) this would correspond to 90 yachts giving up their place at the Rapallo port for a year. The yearly average rent for a yacht in the Marina is about 2000 Euro, so the total would be a one-time loss of 180 000 Euro.

Concerning the effects on human health or increased mortality risk, calculations can be made using values of a statistical life (VOSL, or a statistical death avoided, SDA) from e.g. indirect labour costs or transportation studies, or direct methods that determine the willingness to pay for mortality risk reductions. By way of illustration, the indirect methods give results for the value of a statistical death avoided of between 1 and 17 million dollar (2000), with an elasticity of income between 0.5 and 0.6 (Viscusi and Aldy, 2003). The direct methods give somewhat lower values between 400 000 and 2 million dollar.

These illustrative figures for the consequences of the storm of November 6th 2000 for the two Marina's at Rapallo show that justifications for costly works to prevent wave overtopping damage in future events will hinge critically on the decision whether or not to include the valuation of human lives at risk into Cost-Benefit Analysis. Furthermore, the stringent visual impact criteria with respect to coastal defence limit the possible alternatives to be evaluated. Such criteria safeguard against changes in landscape values (the visual attractiveness for users as well as neighbouring inhabitants), but they also illustrate that the results of assessment methods such as CBA should be interpreted within a broader policy framework.

4.2. De Haan (Belgium)

De Haan, a densely populated tourist location, is centrally situated at the Belgian coast. Its beach is used for recreational purposes and different water sports such as sailing and windsurfing can be practised (Haecon, 1992). De Haan has three nature reserves, one of which is situated immediately behind the dunes. The coastal barrier at De Haan protects the polder lowlands. It suffered from severe erosion over the last 25 years (Malherbe and Lahousse, 1998). The Belgian West coast was hit by a severe storm in 1990, which had a statistically determined return period of 63 years (De Wolf et al., 1997). In the vicinity of De Haan, the beach almost disappeared and threats of floods became very real. The sloped seawall foundation was eroded.

In Belgium, as well as in other countries such as the Netherlands, there is a tendency towards soft engineering approaches in dealing with coastal hazards. As natural processes become increasingly important within coastal defence, solutions such as sand suppletions are preferred to the more traditional approaches of constructing "hard" coastal defence structures such as seawalls, groynes or breakwaters (see e.g. Charlier et al., 1989). Sand addition is also sometimes combined with hard defence structures. After the 1990 storm in De Haan, the Flemish regional government opted for the approach of beach nourishment, a "soft" coastal defence measure, using sandfill following the profile nourishment feeder berm concept (profile nourishment in combination with a feeder berm, using sand suppletion beneath the water surface) (Malherbe and Lahousse, 1998). It was the first time that the feeder berm concept was executed in Europe (Administratie Waterwegen en Zeewezen, 1995). After a multi-criteria analysis of different solutions, this appeared to be the most appropriate and cost-effective system (Helewaut and Malherbe, 1993). The multi-criteria analysis took into account the actual morphodynamics, the technical feasibility and the budget constraints (De Wolf et al., 1997).

A certain ambiguity can be detected in the debate on "soft" or "hard" coastal defence solutions. On the one hand, "hard" measures can impact recreation negatively, e.g. when leading to a reduced contact with the sea. At certain locations however, the opposite is true. In the case of Ostend (Belgium) e.g., the direct contact between the sea and the dike has been put forward in the past as an argument against a beach nourishment scheme. Other examples of positive experience values that people attach to dikes can be given (e.g. Den Helder in The Netherlands) (Kapoerchan, 2003). "Hard" structures might also be perceived by the public as providing better protection (Townend and Fleming, 1991).

The current policy in Flanders is to protect against damage instead of protecting against a certain water level (Stevaert, 2000). 'Risk' replaces 'probability' as a central concept, whereby risk is defined as the 'probability of an event multiplied with the damage caused by the event'. This implies that there is a trade-off between the probability of an event and the potential damage. If the damage caused by flooding is large, the probability of occurrence needs to be lowered (Vlaamse Regering, 2001). Safety requirements can be slightly less stringent in areas where flood damages are less severe. As demonstrated by Verhagen (1990), who explored the cost factor in the decision-making process for coastal works in The Netherlands, similar tendencies can be found in other countries.

Current water control strategies are based on socio-economic considerations in which both the consequences of potential flooding, as well as the costs related to flood protection are important. In the past however, the value of the protected area was not explicitly considered in decision making processes. Consequently, monetary values of the benefits of the coastal defence works that have been carried out in De Haan are lacking.

The costs of the coastal defence works are better documented. When looking at these costs, both the costs of execution as well as maintenance costs need to be taken into account. On average, maintenance works related to beach nourishment projects are carried out after 5 to 10 years, depending on the erosion rate.

The first phase of the coastal defence works, located at the centre of De Haan, involved the installation of ca. 1300000 m^3 of sand (feeder berm + profile nourishment) over a length of 1990 m. The works were carried out in the period 1991–1992. The nourishment at the centre of De Haan is designed to withstand two consecutive storms with a wave height with a 50-year return period (Administratie Waterwegen en Zeewezen, 1995). A second phase, which concentrated on the zone westwards of phase 1, was started in 1993 after the severe storm of November 14, 1993. It ended in 1995. This second phase also included a nourishment of the dunes, on top of the feeder berm and profile nourishment (length: 3480 m). The same safety level holds as for the first phase. By 1995, a total amount of 3 506 600 m^3 had been nourished in and westward of De Haan since 1991. The works in De Haan were carried out in several phases mainly for budgetary reasons (Administratie Waterwegen en Zeewezen, 1995).

The problem of overtopping is most relevant at the centre of De Haan. Table 3 gives an overview of the volumes of sand that where involved in this area between the beginning of the works in 1991 and 2000. In accordance to the principle "work done with work", this sand originated form harbour access channels that had to be dredged anyway (De Wolf et al., 1997).

For the centre of De Haan, the costs of execution amounted to 7928 million Euro or 3983.7 Euro/metre protected coastline. 6661 million Euro was related to the profile nourishment (Administratie Waterwegen en Zeewezen, 1995). Maintenance costs need to be estimated and added to this figure in order to obtain a global picture of the costs. It should be noted that if no coastal defence works were undertaken, the beach needs to be levelled up yearly. By means of illustration, the cost of the nourishment in 2000 amounted to 1497840 Euro.

To what extent can CBA make a useful contribution to the assessment of coastal defence projects such as beach nourishment schemes? Coastal defence schemes are not longer only related to safety purposes. This is especially the case with nourishment schemes. Beach nourishment increases safety levels, but also adds to the recreation facilities in the area. The importance of recreation and tourism in coastal zones has risen over the years and this trend is expected to continue in the future. A balance has to be found between safety, recreation, nature, economic functions and housing (Kapoerchan, 2003). This broader perspective is a positive evolution, but it also complicates the monetary expression of costs and benefits. Within a purely neo classical CBA these various aspects might not be sufficiently accounted for.

Townend and Fleming (1991) illustrate the validity and limitations of economic appraisal with respect to beach nourishment

Table 3
Sand volumes involved in the coastal defence works at the centre of De Haan

Year	m^3	
1991–1992	661787	Feeder berm
1992	794364	Profile nourishment
1999	18467	Feeder berm
2000	260493	Profile nourishment
2000	101989	Feeder berm

schemes by means of two case studies. They highlight the importance of budget constraints. Budgetary considerations also played a significant role in the coastal works at De Haan. Such constraints make it difficult to compare options with different life spans by means of CBA, as expensive projects with benefits that occur over longer periods of time are sometimes excluded in advance. The same arguments hold for design criteria that need to be met. Design criteria for beach nourishment schemes, or other coastal defence projects, confine the number of possible alternatives that are taken into consideration. On the other hand, the fact that costs can be spread over time should be considered as one of the advantages of beach nourishment schemes.

5. Conclusions

Policy makers that decide on the acceptable level of wave overtopping will be confronted with the assessment, either explicitly or implicitly, of both the costs and benefits of controlling overtopping. This is not a straightforward task, as the consequences of overtopping events are both site- and event-specific. Moreover, these assessments take place within a decision-making context that is different for every country. The neoclassical approach towards CBA might not be the most appropriate instrument to inform decision-makers on the implications of coastal defence strategies.

Valuation is a process which asks for a number of assumptions. A first step is to identify the types of values which need to be considered, including the decision whether or not to explicitly incorporate the valuation of human lives at risk. In many cases the context of decision-making is such that the explicit valuation of the values of human lives at risk will not take place. Decision-makers might deal with it implicitly by introducing safety norms. These norms do not necessarily define the acceptable level of overtopping (defence standard) but might also provide standards with respect to acceptance of human activities (Allsop, 2004).

Both formal and informal rules impact the outcomes of assessment methods such as CBA. The enforcement of visual impact criteria and budgetary constraints preclude the use of certain coastal defence strategies. Design criteria further delimit the number of options. Evolutions in related sectors also influence the appraisal of different policy options. The amounts of sand that are available through dredging operations lower the costs related to beach nourishment (Verhagen, 1990). Currently, the opinions of policy makers about climate change make the assumption about how to assess the impacts on future generations quite relevant.

We emphasize that valuation is a process that starts with clarifying the perspective of decision-makers. To a large extent, decision-makers are steered by the context within which they operate. Policy makers that face a decision on acceptable safety levels in coastal regions are confronted with outcomes of Cost-Benefit Analyses in which assumptions about what aspects of ecology, social and economic systems need to be considered and how to value them are not always clear. Transparency about which rules of the game apply are critical for the interpretation of the outcome of a CBA. This paper shows the relevancy of clarifying these assumptions and underpins the necessity of transparency about the process of valuation.

Although Cost-Benefit Analysis and the valuation of environmental effects are generally associated with a neoclassical economic approach, this does not imply that they serve no purpose according to the institutional view. From an institutional perspective, they have a different role to play. It is important to be aware of the limitations of monetary valuation and CBA in order to bring about a shift in the management of flood and overtopping events. The promising synergies between neoclassic and institutional perspectives might be the key to reverse the trend of ever increasing potential damages that are wrongfully justified by an illusory feeling of safety.

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