Valuation of Flood Risk in the Netherlands: Some Preliminary Results

M. Bočkarjova, P. Rietveld, E.T. Verhoef

VU University Amsterdam, Department of Spatial Economics, de Boelelaan 1105, 1081 HV Amsterdam, The Netherlands

ABSTRACT: So far no extensive literature exists on the valuation of extreme natural hazards pertaining low frequency and high potential impact. In this paper, we attain to fill this gap with the study of flood risk in the Netherlands by means of a stated preference approach. From the choice experiments in our large-scale questionnaire, we expect to receive the estimates of the value of statistical life in flooding, the valuation of inconvenience from getting an injury in flooding and the valuation of inconvenience from a precautionary evacuation. There are two persistent problems encountered in this research: extremely low yearly probabilities of a flood and of dying in a flood (which might be ignored by the respondents in making trade-offs); and flood protection being 100% public responsibility that might further depress individual risk valuation. In order to overcome these problems in our survey, we provide respondents with extensive visualised probability explanations, such as graphic grid paper and risk ladder, before presenting them with choice experiments.

1 INTRODUCTION

In this paper, we shall address some issues connected to the valuation of flood risk in the Netherlands and present some preliminary results. We use a stated preference approach for the elicitation of individual prefences with respect to flood risk and develop a questionnaire to be spread among the inhabitants of dike rings (with various levels of protection) in the Netherlands in the first half of 2008. We conduct three choice experiments, from which we expect to receive the estimates of the value of statistical life in flooding, the valuation of inconvenience from getting an injury in flooding and the valuation of inconvenience from a precautionary evacuation. There are two persistent problems encountered in this research. On the one hand, we have to do with extremely low yearly probabilities of a flood (down to 10^{-4}) and of dying in a flood (down to 10^{-6}), which might be ignored by the respondents in making trade-offs. On the other hand, this is further strengthened by the situation in the Netherlands where people see themselves as 100% protected from floods behind the dikes, which *a priori* imposes a significant 'enthusiasm bias' on their perception of flood risk that may depress individual risk valuation. Attaining to neutralise these effects, we provide extensive visualised probability explanations using graphic grid paper and risk ladder. So far we have not found much literature on the valuations of flood risks, so the current study will not only supply information to be used in flood management decisions for the Dutch policy-makers, but also provide valuable insights to the field of natural hazard research.

It has been noticed (see for example Mitchell 2003) that flooding threats are becoming a matter of increased concern in Europe. Mitchell distinguishes a number of driving forces behind these developments embedded in a dominant consumer-oriented economy, which in fact also contributes to the increased risks of flooding. Among others, he is mentioning such factors as the movement of exporting industry to waterside locations; the phenomenon of North to South industrial migration; shift towards transportation infrastructure, watershed protection and water supply, nature conservation, and recreation as more important floodplain land uses than traditionally dominant agriculture; landscapes and ecosystems that become extensively modified by humans; growing urbanisation, and others. Mitchell notices that these processes are in particular characteristic of Europe, and are even more intensified by the decreasing willingness of European nations to tolerate floods, imposing high flood-protection standards, probably pioneered by the Netherlands which seems to become a 'zero-risk' society (see also Tol et al. 2003, p.579). These developments together with the pressures posed by the ongoing climate change, as never before, point at the need for thorough research, exploring the damage potential in the areas at risk, weighed against preventive measures that can be taken to provide better protection to such flood-prone areas to support policy and action.

Among a variety of consequences a disaster may bring about (such as loss of life; psychological traumas; devastation of property and assets; curtailment of human activities caused by failure of public services; interruption of business and production activities; damage to historical and cultural heritage; decay to pastures and arable land; destruction of environmental conditions, ecological imbalances, and so forth), damage in general is a measurable category, and represents a quantification of society's vulnerability.[1] Economic damage in particular occupies a special place in disaster consequence assessments, which bring about a whole gamut of consequences. Damage can be classified into direct and indirect damages based on the spatial distinction (as inside and outside the flooded area, respectively), or a stock-flow differential. Another distinction is made between material damages that are tangible and can be priced; and immaterial damages, for which no markets exist. The purpose of an *a-priori* assessment of economic damage is gaining insight into the damage potential that a hazard may bring, as well as exploring the options that are open for mitigation and adaptation measures.

2 ISSUE OF FLOODS IN THE NETHERLANDS

One of the important recent developments in Dutch water management and policy signal a shift in thinking about flood threats. For centuries, both sea and rivers have continuously been a source of danger. The Delta Plan, which came into being after the disastrous 1953 flood, has for decades set the stage for flood protection in the Netherlands. This was based on the concept of very strong primary defences, organized to withstand extreme water levels. For the highly developed and populated central part of the Netherlands, this amounted to a chance of a flood up to once per 10.000 years. We can notice that this permitted a spectacular economic growth in the provinces below sea level, which ultimately made the country a world player on many markets. However, the discrepancy between the infinitesimal dike overtopping probability, and the alarmingly increasing expected losses resulting in a high and ever growing risk of flooding (we shall clarify shortly), demand a different type of approach. It means that the country has to prepare itself for future challenges connected to the rising *risk*, in this context finding a balance between expected probability and potential losses, and growth and development agendas.

These recent changes in the view on water management in the Netherlands have led to a change of approach from one based on probability, to one based on risk assessment. Risk, in turn, is the concept including the interaction between the probability of an event to happen (like a major flooding) and the consequences that this event may bring about. In other words, risk is the product of probability and the effects of the expected calamity. Adopting a risk management approach in fact requires a framework that takes the multifaceted effect side of a disaster explicitly into account. At the same time, there is a need for the assessment of the potential economic (material and immaterial) damage that a flood may cause. If taken on board, this new initiative may in the long run lead to direct implications, like even more differentiated protection standards (see for example Duits, 2007) or implications for spatial planning and physical asset and population re-distribution in the long run, accompanied by a further chain of reactions throughout various facets of contemporary society.

A wealth of issues surrounds the spatial dimension. First, many of the issues on today's agenda are a consequence of how Dutch spatial structure has developed. The country is basically a patchwork of interconnected polders, and each has different characteristics such as population, economic value, and different safety standards. Some figures on the potential damage per dike ring could illustrate further the differences between the units of protected areas (from Floris report, MTP 2005) on flood risks and safety in the Netherlands, providing maximum direct physical damages) which range from €160mln for Terschelling (an island with limited amount of economic activity) to €290bln for Zuid-Holland (one of the western coastal provinces with high concentrations of inhabitants and economic assets). Taking into account the varying protection standards, expected *yearly* damages (i.e. risk) are €0,1mln for Terschelling; €116mln for the provinces of Zuid Holland and Noord Holland; and almost €200mln for Land van Heusden/De Maaskant and Betuwe, Tielerand Culemborgerwaarden. Number of expected victims of a flooding varies greatly by dike ring, depending on the assumptions about flood characteristics and evacuation capacity; for example, in Noordoostpolder are estimated to vary between 5 and 1400, and in Zuid Holland – between 30 and 6100 (see MTP 2005, as well as Jonkman 2007 for more detail concerning methodology for the estimation of the number of fatalities). Expected yearly number of flood victims are estimated at 0,042 for Noordoostpolder; 0,28 for Zuid Holland, and 1,31 for Land van Heusden/De Maaskant.

We have to note at once that provided figures are rough estimates; tailored flood probability and damage calculations should be based on the much more complex concept of systemic risk where a

[1] Essentially, the study of hazards can be described by the notions of vulnerability, resilience and adaptability, which have recently become a topic of particular interest and wide debate in scholarly research. We shall refer the reader to Bočkarjova (2007) for the discussion of these terms.

number of dike rings should be seen as an interdependent system. Connected to this is the issue concerning the present spatial distribution of activities, in particular the question whether or not the Western part of the country can remain as prominent in Dutch society as it is now. Systematic factors do not look favourable: sea level rise, subsiding ground level, increased precipitation and the expectation of more extreme peak river discharges. The Netherlands has to decide how it will develop in the next decades. Second, there is another issue specific of Dutch situation, which concerns the role of government, namely its increasing willingness to share the responsibility of flood risk management (Wouters 2006a,b). One of the aims of this trend, which may eventually become a policy vision, is to make the public more aware of flood risks by means of involving private actors in decisions connected to water management and flood protection on the basis of sharing a part of associated costs. Connected to that is the topic of insurance that tends to reappear more often on the public debate agenda (Botzen & Van den Bergh 2006, 2008). It is yet complicated by the presence of catastrophic losses, interdependence and ambiguity, all of which makes it troublesome for private insurers to define the amount of premiums, as well as to ensure the presence of capital to satisfy all disaster-related claims simultaneously.

Given the increasing complexity in which modern societies like the Netherlands are operating, it is nearly impossible to solve water management and (large-scale) flooding problems without embedding them in the broader context of economic development as was the case in earlier times. The seamless interaction between water and economic networks offers rich grounds for debate, which we believe should improve our vision on the water and flood protection problems in future. We can see that a number of questions appear following the issues discussed above, like: Should the core economic activities be located in the areas directly behind the dikes be still protected, or should a policy of spreading these activities to the higher areas in the Eastern and Southern parts of the Netherlands be adopted? Also, what is a possible mix of private and public solutions that could ensure countries adaptability in the long run to the threats of climate change? In this context, further research on the economic dimension of disaster consequences will be needed as an essential part in understanding, explaining and steering contemporary economies in the direction of the desired development trajectories. Here, a cost-benefit approach from welfare economics is a good candidate to analyse various adaptation measures and policies.

3 VALUATION OF FATAL RISKS

In this section, we shall discuss the value of statistical life (VOSL) as one of the aspects of immaterial damage in the context of flood safety in the Netherlands. VOSL is one of the common ways to evaluate the risk of a fatality. It signals how much an individual or a group of individuals are willing to give up in order to decrease the expected number of fatalities in a given context (like traffic accidents, or industrial accidents), by one. It is important to clarify that in this case, the average number of victims or fatalities is being decreased, and thus it is not known in advance whose life will ultimately be saved. That's why the term 'statistical life' is used. Moreover, a VOSL reflects essentially the willingness to pay for a reduction in risk (rather, probability of an adverse event with a lethal outcome), and therefore is not intended to determine the value of a human life. [2]

For example, in labour economics, the differences in wages between 'safe' and 'unsafe' jobs can be compared (using appropriate econometric methods, to which we shall return later in this section) to the differences in fatality rates, and in this way monetary values that employees attach to the safety at the workplace can be translated into the value per fatality. In the studies of VOSL in transport safety (see, e.g. De Blaeij 2003), the willingness to pay for a safer or less safe car; or the willingness to pay for a safety device reducing driver's chance of a fatality are related in a similar way to the number of reduced expected fatalities. This way, the compensation for risk is transformed into the value of statistical life, which in turn can be used as a threshold to value changes in risk of a fatality in general.

However, in practice the valuation of a VOSL, as found by Daniel *et al*. (2005b) most probably reflects not only immaterial damages, but also includes loss of consumption. Also De Blaeij (2003) reflects that VOSL estimates are based on the respondents' maximum WTP, which presumes that measured VOSL includes total benefits, for which agents are willing to pay, i.e. as for the reduction of risk of suffering, as for the reduction of risk of foregone future utility of pleasure through consumption. In addition, numerous studies have shown that a VOSL is not a constant, but rather varies dependent on the personal characteristics of the surveyed population and the context in which

[2] It is important to distinguish between two concepts here: the "valuation of risk", VOSL, as we are tackling it in this article; and determination of the "implied value of life", which is rather addressed in Vrijling & Van Gelder (2000). This implied life-value is, as defined for example by Ramsberg & Sjöberg (1997, p.468), "simply the cost-effectiveness of a livesaving intervention, measured as cost per life saved."

VOSL is measured. For example, the higher the level of income, the more people are willing to pay for extra increase in safety, which pushes VOSL up. Another aspect that can be of importance in VOSL estimations is the initial level of riskiness. Namely, the higher the initial risk, the more people are willing to pay to contribute to its decrease; the lower the initial risk level, the more VOSL tends to decrease.

3.1 *Some Background on Valuation Approaches*

To evaluate various measures directed at improvements of flood safety, a cost-benefit approach (CBA) is often used. Essentially, it compares alternative options in terms of streams of benefits against respective costs (including initial investment and maintenance).[3] In this way, several considered alternatives can be compared. To be able to account for all or at least as many as possible costs and benefits, these should be expressed in the comparable units, which are often assumed to be money terms. Yet, it is not equally straightforward or easy to provide a monetary value to assets of different nature. Probably, the simplest assets to value are market goods; they have a price determined on an existing (competitive) market. Although shadow prices may still differ, this provides a first starting point for determining the unit value. Non-market goods often need to be valued indirectly, as they are not directly traded, and thus do not have an established price. These are, for example, environmental goods, where extensive valuations are well documented.

Valuation methods aim to estimate the individuals' marginal 'willingness-to-pay' (WTP) (in monetary units) for improvements in the quantity or quality of a non-market good concerned, and are therefore consistent with the general philosophy of CBA, in which relevant welfare effects are expressed in monetary units. Economists have developed a number of procedures, which, at least in the case of some externalities, do provide reasonable guidance to the monetized value of these effects, despite the remaining uncertainty and dispersion in values produced (Button 1993). In recent years the level of sophistication used in this process has risen considerably. Two types of approaches to value environmental goods exist (see table 2), namely, behavioural and non-behavioural ones.

While non-behavioural techniques are used widely in practice, providing 'hard' estimates, following Nijkamp et al. (2002), they are not taking into account non-use value of assets, as well as they fail to relate valuations to consumer utility functions. Behavioural approaches, alternatively, are preferred on theoretical grounds, as they provide directly consumers' valuation of the selected asset. Two main categories of behavioural techniques are distinguished here, revealed and stated preference methods.

Revealed preference techniques can be applied when surrogate markets for the environmental good to be valued exist; that is, when consumers' marginal willingness to pay for changes in the effect can be measured by looking at their behaviour on other, related markets. Such other markets may be housing markets and labour markets when hedonic techniques are used to statistically infer the value of, for instance, noise annoyance as an attribute of housing services, or safety as an attribute of jobs. In Daniel et al. (2005a, 2006a,b) the effects of the flood risk on the property values in the Netherlands along the river Meuse (including the so-called emergency inundation areas, in Dutch, '*noodoverloopgebieden*') are explored with the help of hedonic pricing model based on the actual data of housing transaction prices. The so-called travel cost method would typically seek to measure the valuation for, e.g., natural parks by looking at the expenses that visitors make in order to see the park. Household production functions can be used then to infer how households, in their 'production of utility', try to defend themselves from the impacts of certain externalities.

When the goal is to value non-use values, or when no surrogate markets exist, stated preference techniques can be used to infer consumers' willingness to pay by confronting them with hypothetical markets or goods. Contingent valuation studies try to ask for a willingness to pay directly, possibly by confronting respondents with various bids for a certain good. Conjoint analysis techniques typically confront respondents with two (or more) scenarios in which the quantity or quality of an environmental good and some financial transfer vary, and ask them to indicate the most preferred option. Essential to stated preference methods of valuation are the explanation of known probabilities, which aims at the collection of objective valuations from the respondents based on the realisation of factual information instead of subjective perceptions. Yet, because the above-mentioned methods are always indirect or induced values, valuation of non-market goods will always remain an approximation.

3.2 *Valuation of VOSL in Flood Safety in the Netherlands*

In the above we have briefly introduced the concept of the value of statistical life, and the valuation methods that can be applied for its determination in

[3] For an overview of issues connected to CBA appraisals, see *inter alia* Nijkamp et al. 2002.

the framework of a cost-benefit analysis. In this subsection we shall follow the discussion around the stated preference method for the valuation of VOSL in the Netherlands.

We have found only a few exmaples of VOSL valuation in hazard context in the literature (among others, avalanches in Austria by Leiter & Prunckner 2005; floods in India by Bhattacharya et al. 2007; air pollution in Thailand by Vassanadumrongdee & Matsuaoka 2005). Thus, we shall start withl outlining a number of issues that are of importance for the determination of VOSL in the context of flood safety in the Netherlands. One of the first issues that comes to the surface is the current level of flood protection that exists in the country. Legal standards for dike construction are defined at the tolerated level of dike overtopping mounting to once in 1.250, 4.000 years and even once in 10.000 years for the Western part of the country, which are extremely strict comparing to other flood-prone places around the globe (where often once in 100 years is considered as enough protection). This means, that we are dealing with small, and most probably, very small probabilities, which often proves to be a difficult task to explain to the respondents.

The issue is complicated by the fact that the probability of a fatality due to flooding is of composite nature. In the Netherlands, which consists of dike rings and polders, this means that the probability of a flooding should be determined for each specified locality, based on the information about various dike failure mechanisms (see MTP 2005), including overtopping. This aspect is being studied and attempts at modelling it are made (see, for example, Jonkman & Cappendijk 2006), however, extensive standardised information on flood probabilities per dike ring, though available, requires more underpinning with localised information to obtain reliable estimates. Further, the probability of a flooding, even if to be roughly substituted by the legal standard for dike ring safety, should be multiplied by a probability of the emergence of a fatality in case a flooding takes place. The problem is that the latter probability has to be modelled separately, too, while a constant number, or a known proportion for the determination of a number of fatalities in flooding, strictly speaking vary per locality even within a single dyke ring. Jonkman (2007) offers such a model, yet it remains sensitive to the underpinning assumptions; which should in turn be strictly controlled for in an SP environment.[4] One of the accepted 'rules of thumb' that we also – not unreasonably – use as a starting proxy (following Jonkman 2007) in this field of study is that 1% of the affected population becomes a victim of flood. This will bring the expected yearly probability of a fatality due to a flooding for the inhabitants of some of the dike rings in the Netherlands to one in a million (i.e., 10^{-6}), which is an extremely low indicator. One further comlication is the irregular (rather, catastrophic) character of major floods in the Netherlands. Because these do not occur yearly, like a car accident or a desease, the expression of flood risk in terms of yearly probability requires from respondents strong imagination abilities in order to estimate the risk correctly. We may expect to have difficulty in explaining such low probabilities to the respondents (also stressed by Brouwer & Schaafsma 2006), and should look for an appropriate manner to present this information as much comprehensive as possible. Here, often risk ladders and colour grid representation are used, which we also adopt for our purposes, alongside with a comparison to a city indicating a number of expected deaths per flood event that provides information about the scope of a calamity to the respondents.

Another question connected to the initial level of risk is the existence of a positive VOSL. Here, possibly, also the status of flood safety as a public good may play a role. Already at an early stage of research, it became apparent that the usual practice in SP approaches of providing the respondents with alternatives, asking to make a trade-off between a sum of money and the level of *individual* risk reduction, becomes troublesome. On the one hand, the trust in government as a provider of safety is important in considering flood defences. On the other hand, if the changes in safety cannot be attributed to a single person, then it has to be attributed to a known size of a group of individuals, which is not certain in our case.

Atop of the points that we have outlined above there are known biases that accompany SP valuations, like the (in)sensitivity to the scope of the good - embeddedness; hypothetical nature of choices; yeah-saying; choice of payment vehicle; and others (see for example De Blaeij 2003 for an outline of biases associated with SP methods). All this signals that we should exercise caution in setting up an SP questionnaire, designing our experiment. The wording of questions, the order of questions and the amount of questions presented appear to play a role, and ultimately affect the VOSL estimate, in this type of semi-experimental setting.

[4] As an aside, estimation of mortality rate in flooding can be further complicated by the issue of evacuation, where the reach of the message, perception of flood warning and compliant action play a role. In constructing our questionnaire, we explicitly control for this variable.

4 THE SURVEY

We apply a survey to explore flood risk valuation in the Netherlands and to provide an advice with regard to the order of magnitude for VOSL and other indicators of immaterial damage. The design of the survey will consist of a testing stage in the form of a small-scale pilot study (Mar-Apr 2008) and a final large-scale survey (Aug-Sep 2008), expectedly to be distributed among about a thousand Dutch households located in flood-prone areas as along the coast, as along the riverside, with varying levels of protection (legal standards prescribe the following overtopping probabilities for the intended dike ring areas are: 1/10.000 yrs; 1/4.000 yrs; 1/2.000 yrs; 1/1.250 yrs). Three choice experiments, as well as a WTP and a WTA type of questions are included to obtain individual immaterial loss valuations.

The questions in the questionnire are divided into a number of blocks. The first block starts with some opening questions about the choice of location and flood risk perception, as well as some questions about the current state of flood safety in the Netherlands. These questions serve as a prelude to SP experiments, making respondents getting used to thinking about the issue of flood, that is not a common daily topic of conversations (supported by the observations during the pilot). We provide some pictures and maps as well as some factual data to the respondents so that they get some background information on the topic while providing their answers. We further proceed with the expalnation of flood probability and the probability to die in a flood in the place of residence of a respondent (this information differs through dike rings). We use color grid paper, risk ladder, throwing dice example, and a comparison to a city with a number of expected flood victims for these purposes. The pilot should provide us the roadmap to which explanation type(s) is most effective and appealing to the respondents that will furhter be used in the final questionnaire.

Block two follows with choice experiment questions, where each respondent fills out two out of three choice experiments. Color cards with symbolic drawings accompany the explanation of attributes that vary from 3 to 5 through an experiment. Attributes that are included are the probability of a flood, of beong a deadly victim of a flood, of getting an injury in a flood, of getting evacuated, commuting time, and a monetary attribute. The pilot reveals that while the setting of choice experiments is sometimes perceived as unnatural or unrealistic, respondents are mostly in state to make good choices. Choice experiments are followed by a WTP or a WTA question to obtain a direct valuation of flood mortality risk. We should notice at once that respondents are rather willing to pay for extra safety (in terms of expected number of flood victims) than to accept the reduction in payment in exchange for an increase in the number of deaths.

Two subsequent blocks deal with questions related to (near) flood and evacuation experience, and hypothetical questions about possible evacuation in the future (differentiated for the residents of riverine and coastal areas). The questionnaire closes with some questions around climate change and some personal questions.

5 SUMMARY AND EXPECTED RESULTS

We use a stated prefence method to elicit flood risk preferences within a sample of dutch population living in flood prone areas. The use of this method ensures that, while some biases remain, as objective as possible valuation of risk is obtained. Three choice experiments are offered to the respondents to obtain the VOSL valuation, as well as valuation of immaterial damage related to injury and evacuation inconvenience.

The pilot, which we test among a small group of respondents (about 30), is well taken, and we do not expect major changes to come before the questionnaire is distributed among the final sample. However, minor improvements are necessary, and include some rephrasing of questions (for example, a simpler and shorter formulation of the WTA question that should prevent arising confusion; more precise formulation of one of the choice experiments; exhaustive response options, and the like), some spelling and editing faults. Next, while interpretation and comparison of low probabilities (of flood and dying in a flood) remain an issue, this is substantially eased by the presence of visual aids. It will even further be enhanced in the final survey (either internet-based or as a CAPI), where technical solutions make possible the use of these aids continuously during the choice experiment. Current pen-and-paper version of the pilot presents in this respect a limitation that we expect to overcome in our final survey.

There are a number of findings that are worth reporting from our testing phase. The three choice experiments (CE's) are taken quite differently by the respondents. Contrary to our expectation, that an experiment with the least number of attributes (3) is seen as the most difficult. There may be two reasons for that: on the one hand, this CE is always shown first to the respondents, and they might need time to get used to the particular format of the question and the cards, comparing the alternatives. Learning effect, as we suspect, makes filling out of the CE that follows (with 4 or 5 attributes) easier for the respondents. Another reason – provided by the respondents themselves – why CE#1 is seen as more difficult is the setting of the question that concerns the choice between two plans of the Water Boards for flood safety in the place of residence of the respondent. It appears that respondents are not that familiar with Water Boards and their activities and therefore 'do not feel at home' in such an artificial choice position. Two other CE's, on the contrary, appear to put respondents in a more familiar situation, and thus perceived as more realistic, when they are asked to make a choice between two locations of residence. These findings point at the need to reconsider the setting of the CE#1, or possibly place it after a more simple CE in the questionnaire, when respondents have learnt to get around in the experimental setting. The important issue to bear in mind to this instance is how reliable the answers are, and thus what is the value of risk valuation that would be obtained based on the choice experiments. The pilot shows that in most cases, respondents do take most of the attributes while making a trade-off, and also manage not to think of their previous choices when making a following one. Possibly, to warrant the quality of our data for analysis, evaluative questions as for the way respondents made choices should still be included in the final survey.

First, the pilot, reveals consistently that respondents admit that a major flood disaster may in principle take place in the Netherlands, however are inclined to add "not in my lifetime". Second, respondents tend to perceive flood risk as a public good (or, rather, a 'public bad'), as none of our respondents in the selected sample has attributed payments for the improvement of flood protection to the improvement of personal safety, but rather to that of the family or of the neighbourhood. This is despite the setting of the choice questions formulated explicitly in terms of individual (annual) risk. Both findings are, however, in line with our expectations with regard to flood risk perception in the Netherlands, that has crystalised during the past couple of decades. Yet, these persistent perceptions gauging the answers of our respondents make the interpretation of our valuation results quite troublesome. In fact, if respondents mean to pay for collective, rather than individual protection, then probably what we get to value is a sort of 'value-of-collective-life'. To this end, we may draw on the interpretation in the spirit of 'homo politicus' as opposed to 'homo economicus' (extended literature is devoted to this subject), when individuals act not only considering personal gains and losses, but rather take account of public or collective costs and benefits in their decision-making. The important implication of these differing interpratations lies in the use of VOSL in cost-benefit analyses. Ultimately, it is important to provide a policy-maker with a proper indicator, so that is it duly used in decision-making processes.

We hold some expectations with regard to our final survey, namely on relationships affecting the magnitude of VOSL that are supported by numerous studies in the literature. We would expect that also in our case, valuation of risk is directly related to income, but inversely to age; that valuation of risk is positively related to previous flood or near-flood experiences, and is higher for females compared to males.

As to the current knowledge of the authors of this paper, the studies on the valuation of immaterial damages related to natural hazards, as we attempt to measure with the presented survey and namely the value of inconvenience due to evacuation and the injury, are scarce in number. In particular, we have not found any indcator that would act as an anchor for our flood risk valuation exercise. This means that we are in the perocess of disovering a new research terrain and will have to excercise caution in our exploration. Final results of the survey will be available after it is disctributed among the target population, and will hopefully provide new insights in the state of affairs of flood risk valuation in the Netherlands to date.

6 REFERENCES

Bhattacharya, S., Alberini, A. & Cropper, M.L. 2007. The value of mortality risk reductions in Delhi, India, *The Journal of Risk and Uncertainty* 34:21–47.

Bočkarjova, M. 2007. *Major Disasters in Modern Economies: an Input-Output Approach at Modelling Imbalances and Disproportions*, PhD thesis, University of Twente, Enschede, the Netherlands.

Bočkarjova, M., Steenge, A.E. & Hoekstra, A.Y. 2008. *Management of Catastrophes: A Paradigm Shift in Thinking about Flood Risk* In: H.Folmer & S.Reinhard (eds) "Water Problems and Policies in the Netherlands", World Bank, forthcoming.

Botzen, W.J.W. & Bergh, J.C.J.M. van den. 2006. Bounded Rationality, Climate Risks and Insurance: Is There a Market for Natural Disasters? IVM, VU University Amsterdam, the Netherlands.

Botzen, W.J.W. & Bergh, J.C.J.M. van den. 2008. Insurance Against Climate Change and Flooding in the Netherlands: Present, Future and Comparison with Other Countries, *Risk Analysis* 28(2): 413-426.

Brouwer, R. & Schaafsma, M. 2006. Economische waardering van overstromingsrisico's, Paper pres. at *VU/IVM Lustrum 'De Toekomst van de Randstad'*, VU Universiteit Amsterdam, the Netherlands.

Button, K. 1993. *Transport, The Environment and Economic Policy*, Edward Elgar, Aldershot.

Daniel, V.E., Florax, R.J.G.M & Rietveld, P. 2005a. River Flooding and Housing Values: An Economic Assessment of Environmental Risk. Paper pres. at the 45th ERSA meeting, 23-27 August 2005, VU University Amsterdam, the Netherlands.

Daniel, V.E., Florax, R.J.G.M & Rietveld, P. 2006a. Investigating the Announcement Effects in Flood Risk Management: Using the Designation of Emergency Inundation Areas as a Quasi-Experiment. Paper pres. at the 53rd NRSAI meeting, 16-18 November 2006, Toronto, Canada.

Daniel, V.E., Florax, R.J.G.M & Rietveld, P. 2006b. The Economic Valuation of Flood Risk: Long-Term Divergencies between ex-ante and ex-post Hedonic prices of the Meuse River Flooding in the Netherlands. Paper pres. at the 53rd NRSAI meeting, 16-18 November 2006, Toronto, Canada.

Daniel, V.E., Gent, H. van, Rietveld, P., Rouwendal, J. & Verhoef, E.T. 2005b. De Waardering van Veiligheid in het Verkeer. Regional Economics, VU University Amsterdam, the Netherlands.

De Blaeij, A. 2003. *Estimation of Value of Statistical Life in Transport Safety*. PhD thesis, VU University Amsterdam, the Netherlands.

Duits, M.T. 2006. OptimaliseRing. Gebruikershandleiding van een Numeriek Rekenmodel voor de Economische Optimalisatie van Veiligheidsneveaus van Dijkringen, HKV Lijn in Water in het opdracht van Rijkswaterstaat, RIZA, Lelystad, Nederland.

Jonkman, S.N. & Cappendijk, P. 2006. Veiligheid Nederland in kaart – inschatting van het aantal slachtoffers ten gevolge van overstroming, DWW report DWW-2006-012 (in Dutch).

Jonkman, S.N. 2007. Loss of Life Estimation in Flood Risk Assessment, PhD thesis, Technical University of Delft, Delft, the Netherlands.

Leiter, A.M. & Prunckner, G.J. 2005. Dying in an Avalanche: Current Risks and Valuation, Center of Natural Hazard Management, Working paper.

Mitchell, J. K. 2003. European River Floods in a Changing World, *Risk Analysis* 23(3): 567-574.

MNP & RIVM 2004. *Risico's in Bedijkte Termen: een thematische evaluatie van het Nederlandse veiligheidbeleid tegen overstromingen*. Milieu en Natuur Planbureau, en Rijksinstituut voor Volkgezondheid en Milieu. Bilthoven, the Netherlands. (English version: "*Dutch Dikes and Risk Hikes*").

MTP 2005. Veiligheid Nederland in Kaart. Hoofdrapport Onderzoek Overstromingsrisico's. Ministerie van Verkeer en Waterstaat, Rijkswaterstaat, Dienst Weg- en Waterbouwkunde, Delft.

MVW & MBZ 2007. *Waterbewustzijn en Waterbewustgedrag in relatie tot waterveiligheid. Kennen, voelen, willen en doen*. Ministerie van Verkeer en Waterstaat en Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. Rijswijk, The Netherlands.

Nijkamp, P., Ubbels, B. & Verhoef, E.T. 2002. Transport Investment Appraisal and the Environment, In D.A. Henscher & K.J. Button (eds) *Handbook of Transport and Environment; Handbooks in Transport 4*. Elsevier/Pergamon, Amsterdam, the Netherlands.

Ramsberg, J.A. & Sjöberg, L. 1997. The Cost-Effectiveness of Lifesaving Interventions in Sweden, *Risk Analysis* 17(4): 467-478.

Tol, R.S.J., Grijp, N. van der, Olsthoorn, A.A. & Werff, P.E. van der. 2003. Adapting to Climate: A Case Study on Riverine Flood Risks in the Netherlands, *Risk Analysis* 23(3): 575-583.

Vassanadumrongdee, S. & Matsuaoka, S. 2005. Risk Perceptions and Value of a Statistical Life for Air Pollution and Traffic Accidents: Evidencefrom Bangkok, Thailand, *The Journal of Risk and Uncertainty* 30(3): 261–287.

Vrijling, J.K. & Gelder P.H.A.J.M. van. 2000. An analysis of the valuation of a human life. In: M.P.Cottam, D.W.Harvey, R.P.Pape & J.Tait (eds) Proceedings of ESREL 2000 and SRA-Europe conference, "Foresight and Precaution", pp197-200, 14-17 May 2000 Edinburgh, UK.

Wouters, A. 2006a. Veiligheid & Water, *IGS lezingencyclus 2006*, University of Twente, Enschede, the Netherlands.

Wouters, A. 2006b. Wat Betekent Leven met Waterrisico's? Een Schets van Maatschappelijke Dilemma's, *VU/IVM Lustrum 'De Toekomst van de Randstad'*, VU University Amsterdam, the Netherlands.