Paper III.3

ECONOMIC VALUATION OF FLOOD DAMAGE FOR DECISION MAKERS IN THE NETHERLANDS AND THE LOWER MEKONG RIVER BASIN

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ABSTRACT

Economic activities in flood-prone areas are increasing around the world. At the same time we face changing weather conditions and a rising sea level as a result of climatic change. If no measures are carried out both probability and impact of floods will increase severely. In the Netherlands flood hazard and flood damage are combined in a risk-approach using a cost-benefit analysis for proposed measures. In this approach, risk is defined as the product of probability of flooding and impact of flooding. Could this approach also be applied in the Lower Mekong River Basin (LMB)? As far is the flood impact is concerned one can imagine that flood damage for instance in Chiang Rai in Thailand has other characteristics than a given polder in the Netherlands. One can also imagine that decision makers in the Lower Mekong would make different choices on how to valuate flood damage than decision makers in the Netherlands. This paper presents some considerations on how the Dutch damage assessment tool 'Hoogwater Informatie Systeem - Schade- en Slachtoffermodule' (HIS-SSM) and its underlying economic valuation model may be adjusted to serve the preferences of decision makers in the LMB. It first discusses various economic valuation techniques that are available to determine flood damage and the role of the decision maker. Next the backgrounds on risk-approach and cost-benefit analyses in the Netherlands are described and the opportunities and limitations to use such approach in the LMB are discussed. Finally reference is made to a pilot-project that recently started where the applicability of the Dutch approach is tested. The pilot project forms the link between the available economic valuation techniques for flood damage assessment and ex-ante evaluation of measures in 2T Kok River Basin. Its results are expected by the end of 2008.

ECONOMIC VALUATION TECHNIQUES

Economies need to consequently make choices on what to do with the limited resources available. Flood management can be costly and therefore governments and financiers (e.g. though Official Development Assistance) carefully consider how much they are willing to invest in it. But whose costs and benefits are we interested in? Let's take the example of the flood damage resulting from Katrina in New Orleans. It would depend on whom you are talking to what is included in flood damage. If we were to ask a former inhabitant of the ninth ward about what damage he suffers, he might answer that not only his house but also his entire life has been ruined. He is confronted with tremendous human suffering; the damage done to his personal life is enormous. Would the city of New Orleans be asked the same question they might answer that the social and economic disruption of the city is gigantic, public life has come to a standstill, industries are down, unemployment is rising, investors are pulling away (Kok et al., 2007). At yet another level the government of the United States of America sympathizes for lives lost and damage done and invests in the flood protection measures and projects to revitalize the city of New Orleans. Macro-economically however not much has changed,

investors find new opportunities, industries move to other locations and total export numbers are hardly impacted (Herman, 2006). The estimates of flood damage in New Orleans vary between US$ 30 billion up to US$ 650 billion, the latter being the sum of all claims (of inhabitants, companies and local government) in the court of law against Federal Government (Kok et al., 2007). Apparently different people have different views on how to value flood damage.

When flood damage assessment actually lays the basis for decision-making (e.g. ex-ante decisions such as flood management strategies or ex-post decisions such as insurance payments) the decision maker must carefully consider what damage to include in the decision. Is the decision maker interested in the macro-economic effects, the losses in production or in the human suffering accompanied with a flood? The next question is how to value this damage. If we would define economic valuation as the assignment of money values to non-marketed assets, goods and services (Pearce and Özdemiroglu, 2002), the decision maker has several options to choose from to estimate the economic value of flood damage (based on Ruijgrok et al., 2004):

- *damage cost avoided.* The economic value of flood damage is estimated by the cost of measures to prevent flooding;
- *averting behaviour method.* The economic value of flood damage is estimated by the cost to avoid actual damage and unwanted effects;
- *replacement costs.* The economic value of flood damage is estimated by the costs to repair or compensate for flood damage;
- *productivity costs.* The economic value of flood damage is estimated by the costs of the loss of production of commercially marketed goods;
- *conditional valuation method.* The economic value of flood damage is estimated by creating a hypothetical market in which people are enabled to price flood damage.

In ex-ante decision-making, replacement costs and productivity costs are widely accepted to value flood damage. For instance in the Netherlands replacement costs are used for the evaluation of physical damage to buildings, inventories, terrain and infrastructure and accounts for the flood damage to be fully repaired or replaced. Productivity costs are used for business interruption inside and outside the flooded area. By using these techniques in decision-making, the decision maker actually accounts for the costs to rebuild all damaged goods exactly as they were plus incurred losses of production in- and outside the flooded area. Replacement and productivity costs are also used in Germany and the UK. (Meyer and Messner, 2005). Recently HKV CONSULTANTS applied the same valuation methods on behalf of the Joint Research Centre of the European Union where the damage functions and country specific maximum damage per damage category were harmonized for all EU-27 countries on the basis of replacement costs and productivity costs, relating them to the Gross National Products of the various member states (Huizinga, 2007). The application of replacement costs and productivity costs and its institutional position in the Netherlands is subject of the next section. Other economic valuation methods can also be exercised for instance for the valuation of intangible goods such as human suffering. For instance contingent valuation can be used to assess what people are willing to pay to avert flood risk (Messner et al., 2007). Whether such methods may have added value for use in the LMB is discussed later on.

RISK-APPROACH AND COST-BENEFIT ANALYSES IN THE NETHERLANDS

The HIS-SSM and the Standard Method are used in the Netherlands to determine flood risk and the costs and benefits of flood management measures. In the risk-approach not only probability of a flood is considered but also the possible impact of a flood. To determine the actual risk, the Dutch Ministry of Transport, Public Works and Water management is carrying out a the project

VNK[1] to outline the safety of the Netherlands documenting probability, consequences and risk of flooding of dike rings in the Netherlands. Much research is done to obtain insight in the strength of structures, weak areas of the dike ring and how to deal with uncertainty (Ministerie van Verkeer en Waterstaat, 2008). The potential consequences are being mapped using the national Dutch damage and casualties assessment model HIS-SSM and its associated 'Standard Method[2]'(Kok and van der Doef, 2007). The 'Standard Method' is explained in Textbox 1. Besides the assessment of actual risk, flood damage assessment is also used in cost-benefit-analyses of flood management measures. Since January 1st 2007 all infrastructural measures of national importance in the Netherlands are required to perform a cost-benefit analysis using a format called 'OEI'. OEI stands for 'Overview Effects Infrastructure' and encompasses the assessment of the positive and negative effects of a proposed measure on safety, economy and quality of life. The effects are expressed in monetary terms, i.e. in Euros. OEI is also obligatory for flood management measures comprising an assessment of a proposed measure on the change in risk (Ministerie van Verkeer en Waterstaat, 2007). In other words, for all structural flood defence projects the impact on probability, on flood damage and consequently on risk are determined. Suppose a flood management measure reduces probability of flooding, the change in risk can be illustrated as in Figure 1.

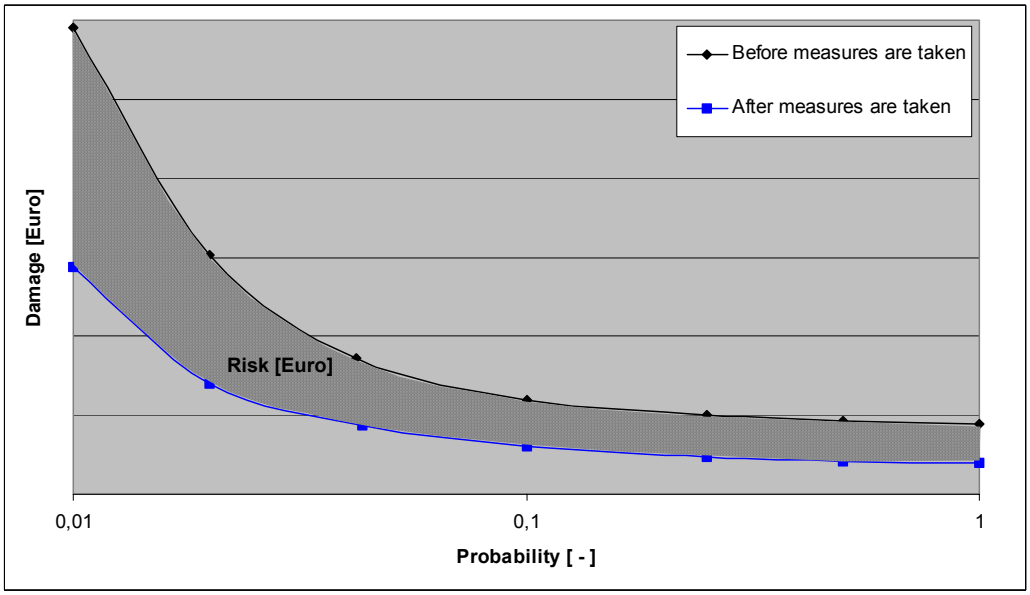

Figure. 1. Probability, damage and risk

In Figure 1 the horizontal axis represents probability, the vertical axis contains the damage and the surface of the shaded represents the change in risk. This change in risk represents the benefit of the proposed measure. The flood damage assessment is done using the national Dutch damage and casualties assessment model HIS-SSM and its 'Standard Method' (Textbox 1).

[1] VNK is the Dutch abbreviation for Netherlands Safety Map. The first phase of the project (VNK1) started in 2001. Results of the second phase (VNK2) are expected in 2010.

[2] The Standard Method was developed in the late 1990's by HKV consultants and TNO, under supervision of the Dutch Ministry of Transport, Public Works and Watermanagement (Rijkswaterstaat). It has been continuously updated since.

HIS-SSM and the 'Standard Method'

HIS-SSM is the Dutch flood damage assessment model. It uses repair- en reconstruction costs, business interruption and an estimate of indirect effects to determine flood damage. The approach to valuate flood damage is captured in the so-called 'Standard Method'. De standard method comprises about 20 land-use types (damage categories). Many of these damage categories are differentiated according to damage type:

- direct damage within the flooded area: due to physical damage to buildings, inventories, terrain and infrastructure. The economic value of the flood damage is estimated by rebuilding/ replacement costs.
- direct damage caused by business interruption within the flooded area: economic damage caused by production loss. The economic value of flood damage is estimated by the productivity costs;
- indirect damage outside the flooding area: economic damage outside the flooded area because transportation routes through the flooded area are cut off or production stops due to lack of supplies from industry within the flooded area. Estimated by the productivity costs.

In the standard method a standard dataset is included covering the Netherlands. The economical damage S (expressed in Euro's) is calculated by:

$$S = \sum_{i=1}^{n} \alpha_i n_i S_i$$

where α_i is the 'damage factor' for category i , n_i the number of units (e.g. houses) in category i and S_i the maximum damage per unity in category i. Each category (i) represents a land use type. The damage-factor α_i represents the effect of hydraulic conditions and is affected by the maximum water depth, rise in water level, flow velocity, a material factor and for built-up areas the type of buildings (Kok et al., 2005). Not included in the method are type of floodwater (salt/fresh), duration of the flooding and seasonal land-cover variations in agricultural regions. The Standard Method has been developed for application in the whole of the Netherlands. This makes the Standard Method easy to apply, transparent and fast. Results are comparable and reproducible due to the fact that related software contains even a standard dataset covering the whole country (Kok et al., 2005).

Textbox 1. Backgrounds 'Standard Method' and HIS-SSM (Kok et al., 2005.

Although national decision-making in the Netherlands is not dependent on the outcome of the cost-benefit analysis in OEI alone, it is increasingly used to determine added value. Critics disqualify the approach because the outcome is approximate. It is widely accepted however that such cost-benefit evaluation provides a better grasp on the benefits of a new measure and that it can be used to stimulate economic efficient public investments. Besides use on national level, HIS-SSM is also used on regional level to evaluate the effectiveness of regional measures against flooding. This includes the improvement of secondary and tertiary dikes within a dike ring area and safety within individual compartments.

OPPORTUNITIES AND LIMITATIONS FOR THE USE OF HIS-SSM AND ITS ECONOMIC VALUATION IN THE LOWER MEKONG BASIN

At this moment a damage assessment tool comparable to HIS-SSM does not exist for the LMB. There are some case studies though on damage assessment in Vietnam (Das Gupta et al., 2004) and Bangladesh (Nabiul Islam, 2005, 2006). Some general flood assessments studies were exercised based on field surveys (Mekong River Commission, 2006, 2007) however, a general tool to obtain insight in spatial variability of damage resulting from different types of floods and

among different sectors in society does not exist, yet. The question is, could such as tool, such as HIS-SSM, be adjusted and made applicable for use in the LMB? At least some essential adaptations with respect to the type of floods and the impact of these floods on society will be necessary. This section discusses the impact of floods on society in the LMB and presents some opportunities and limitations to use such an approach in the LMB.

Impact of floods

The impact of floods in the LMB is twofold; on one hand flooding in the LMB is a source of livelihood and essential for soil fertility and urbanization and on the other it can have a devastating effect on human lives, causing damage to infrastructure, human settlements, essential services and casualties. These devastating effects might even hamper economic development and force the society to remain on agricultural production (Mekong River Commission, 2006. (Messner, 2007) explains that there are social impacts to be considered such as the disruption caused by the flood to the life of the individual household and to the community as a whole and the effects of floods upon the health of the affected people. The impact a flood has on society depends amongst other on the vulnerability of a society or some groups of society. Hereby vulnerability is defined the degree to which some people, or classes of people, are more susceptible to, or suffer from a greater degree of harm from, some hazards than do other people or from other hazards (Messner et al., 2007). But which characteristic(s) of a household and or society determine whether people are vulnerable? One example is a marginal access to income. In a case study on the effect of tidal and flash floods in urban Bangladesh Nabiul Islam (2006) found that people with low-income (living in low-cost houses) were more vulnerable than others, as the percentage of the assets that people lost was the highest in this group. Vulnerability may have a profound influence on the impact of flooding so perhaps we should also account for it? Another consideration is resilience that is closely related to vulnerability, but looks at it from a different angle. Resilience is the ability to cope with disturbances and to persist without huge irreversible changes (de Bruijn, 2005). In general, vulnerable people will be less resilient. Whereas vulnerability demands for measures on reduction of flood risk in order to prevent floods, resilience aims at measures that prepare people on floods where preparedness includes all precautionary activities that enable society to respond rapidly and effectively to floods. In the LMB local authorities are increasingly implementing behavioural and informational measures as part of their flood mitigation strategy, but much work remains to be done (Weichselgartner, 2005).

The effects on human society and individuals can be enormous. In the Netherlands these effects are not accounted for in the flood damage assessment. The question is whether this does right to the human suffering that is accompanied with floods. Perhaps providing such considerations to the decision maker would accommodate economic valuation of floods in the LMB. The difficulty is how to valuate such effects, is there a way to express them in monetary terms.

Economic valuation of the impact of floods

The economic valuation of the direct tangible effects is already being done in the LMB using replacement valuation. However this is not always straightforward and sometimes it is difficult to obtain a clear idea of the financial damage caused: At village level, the communities do not have the tools for making this estimate. At district or provincial levels, only large objects and key infrastructure are subject to an accurate estimate when there are plans for rehabilitation or reconstruction through a tendering process (Mekong River Commission, 2006). Besides the tangible effects, how to valuated the intangibles mentioned in the previous paragraph? When looking at the options sketched in the previous section the replacement and productivity cost methodologies provide insight in the costs to reconstruct society and in the loss of production due to the flood, but cannot be used for the costing of wider social effects. However contingent

or conjoint analysis may be of assistance. E.g. a survey that assesses how much respondents are willing to pay for a reduced risk of flooding would provide information on how people value flood damage. In conjoint analysis the question of payment is avoided, but insight is given in the preference of people for measures on flood risk reduction (Messner et al., 2007). Considering that yearly millions of dollars are spent in the aid industry in the LMB countries to relieve human suffering. In 2006 the gross disbursement of ODA for the Lower Mekong Countries was US$ 3.6 billion (Organisation for Economic Co-operation and Development, 2008). Apparently, as a collective we highly value the well-being of the people in the LMB. Is there a possibility to use the valuation techniques based on what people and organizations are willing to pay to relieve human suffering elsewhere, to valuate flood damage?

The answer to this question lies with the decision maker. We already observed that there are various points of view that can be taken while assessing flood damage and the challenge now is how to present this information to the decision maker. Most flexible would be perhaps, to offer the above considerations to the various decision makers before the flood damage assessment is being done. Why not design a flood damage assessment model offering the flexibility to apply different economic valuation methods of flood damage. In such damage model decision makers may for instance:

- include or exclude wider social impact of floods with a chosen appropriate economic valuation for such effects. E.g. include an evaluation of the costs of human suffering and account for different levels of vulnerability;
- include or exclude the economic potential of a certain area. The return period of flooding and spatial planning are correlated. The decision maker could manipulate the flood damage assessment by altering land-use data and better understand the possible impact of flood management measures;
- include or exclude the possibility to include flood warning as a measure to determine its benefits. Although not much research has been done in this area (Messner et al., 2007) it could be helpful to include a damage reduction factor on flood damage (Penning-Rowsell et al., 2005). The damage reduction follows from early warning of a flood and the resulting use of prevention related measures (e.g. sandbags) and damage mitigation measures (e.g. moving valuables to the second floor);
- include or exclude the possibility to relate flood damage to the Gross National Product (GNP) of a given country. This would help to gain insight in the severity of flood damage.

With such flexibility, more stakeholders in flood management could apply their own standards and preferences. Investors in flood management, whether they are governments or banks, would be presented an overview of the various approaches to flood damage and gain better insight in the possible benefits of their public investment.

PILOT PROJECT IN 2T KOK RIVER BASIN

HKV$_{\text{CONSULTANTS}}$, ITC and the Dutch Ministry of Transport, Public Works and Water management have joined hands to determine whether HIS-SSM and its ‘Standard Method’ indeed has added value for the Lower Mekong River Basin. The project is called ‘DACA’ (Damage and Casualties Assessment). Objective of the project is to develop a damage assessment model for the 2T Kok River Basin in Thailand by adapting HIS-SSM to serve the preferences of local, regional and/ or national decision-makers. In order to do so the interface will be adapted and the database replaced (land-use and economic characteristics). The tool will be tested for three flood scenarios. The results can be used for ex-ante examination of flood risk and to evaluate the change in expected damage if measures were taken. The proposed project consists of three components:

- development of DACA: On the basis of HIS-SSM, the interface of DACA will be adjusted to serve the preferences of local, regional and/ or national decision-makers in the 2T Kok River Basin. The interface can be expanded to alter land-use (spatial planning) and to choose economic valuation method. Next the underlying land-use characteristics are gathered and imported in the damage model and damage functions and maximum damage values will be drawn up using various economic valuation techniques. Result is a full functioning DACA for 2T Kok River Basin;
- demonstration of DACA for different flood scenarios: Aim is to determine three normative flood scenarios and assess the resulting flood damage using DACA. E.g. it would be interesting to determine the damage for an historic flood, a normative flash flood and a normative backwater flood scenario;
- dissemination of results: Whether the implementation of DACA is successful depends on the people using it. Therefore a 5-day workshop is scheduled in which possible users of DACA are invited to run and test the damage model. Besides an actual training on how to use the assessment model we will jointly develop normative flood scenarios, run DACA and test its results and conclusively investigate the possibilities of using DACA in other regions in the Lower Mekong Basin. The results will be incorporated in the final report on DACA and where necessary in the damage model itself. If the application is considered a success a final seminar will be organised in which it will be demonstrated to a larger audience.

This pilot forms the practical link between economic valuation techniques for flood damage assessment and ex-ante evaluation of measures by different decision makers. The political and economic relevance is that by using DACA decision-makers (governments, financiers or others) are enabled to evaluate themselves what risks are taken and whether they consider a measure viable on the basis of their own values and priorities. The results are expected end of 2008.

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