Treatment of future learning: Acceptable Risks Analysis

Key Messages

- Investment decisions on adaptation actions are surrounded by significant uncertainty. Approaches considering flexibility and future learning are becoming increasingly recognised as valuable tools to support decision-making.
- A light-touch method based on the idea of “acceptable risks” can be used to incorporate learning into the economic analysis of adaptation options. After selecting an acceptable level of risk, decision makers can determine what year adaptation actions need to occur to avoid high damage.
- The main advantage of this method is that it can be applied without too much difficulty, as the tools for its application are available. The Acceptable Risk approach can also be used in stakeholder processes and ease the consideration and incorporation of political input into the analysis.

Context

Adaptation must be dynamic because preferences may vary with time and new or improved climate information and technologies may become available. Taking into account flexibility (e.g. of infrastructure design) and future learning (e.g. improved knowledge) into adaptation strategies can be very valuable to support decision-making under uncertainty (Chambwera et al., 2014).

This Insight presents a light touch methodological approach, called Acceptable Risk, to consider the value of flexibility and learning in the economic assessment of adaptation options. Risk is measured through two risk measures: the Value at Risk, VaR, of damage caused by SLR represents the maximum losses that could occur with a given confidence level for a given time frame. In this study the confidence leve is the 95%; the second risk measure is the expected shortfall (ES), which represents the expected loss when the VaR is exceded, in this case, the average damages of the 5% worst cases.

The method is applied to sea-level rise (SLR) and coastal extreme events resulting from climate change and consist of estimating the expected damage distribution of SLR according to the IPCC latest projections. This is estimated for a group of major coastal cities, and the results provide a continuous function of risk in time. Based on these results, local or regional governments could decide an acceptable level of risk for each city. Our function enables to determine when this threshold of acceptable risk would be exceeded, and thus, the year by when each city would need to have adaptation measures implemented.

Policy and methodological developments

The first step is to estimate the total damage costs for the major coastal cities using a continuous stochastic Geometric Brownian Motion (GBM) model to understand the probability distribution of SLR in each moment in time.

For SLR, the model was calibrated using the data from the latest IPCC scenarios, RCP 2.6, 4.5, 6.0 and 8.5 (Church et al. 2013). This allows a SLR distribution function that is log-normal at all times, so there were no negative values. The expected SLR drift is obtained by minimising the sum of the square of the differences with the theoretical values. The volatility is calculated using 1,000,000 Monte Carlo simulations to approximate the theoretical percentile 95% distribution of SLR at 2100 for each IPCC scenario in the calibration process. In the cities studied, mean losses by 2050 taking uncertainty into consideration ranged from US$1,108 billion to US$1,704 billion.
To incorporate risk in the calculation, 1,000,000 simulated SLR values for each scenario and time t are used. Then the expected subsidence level is added to the SLR function, which is specific for each city (Hallegatte et al., 2013). Each SLR for each city and time t causes a specific damage cost.

The second step is to define a level of risk. Defining a level of risk in terms of each city's GDP allows estimation at the desired risk level of the optimal size of the defences in cm needed in 2020 and 2050 to avoid water overflowing. This can be calculated for any given year because of the continuous damage function. The years for adaptation action are obtained by looking for the moment in time when ES (95%) exceeds the maximum acceptable damage (e.g. 0.1%, 0.5% or 1% of each city's GDP). This provides the exact year when each city needs to start adapting to climate change.

The third step involves identifying the optimal size of flood defences (Table 1). Controlling the risk of SLR is achievable by limiting the mean annual loss by a certain year to a percentage of the GDP. This is proposed as a threshold of acceptable risk. The values fall within the boundaries of the estimated investment needs for adaptation (UNFCCC 2007) and annual adaptation costs of SLR (Agrawala et al., 2011). Any other limit could be used, including city-specific values.

Table 1. Optimal size of flood defences (cm) in 2020 and 2050 in order for ES (95%) values to be 0.5% of the city GDP or less (extract from Skourtos et al., 2016).

Urban Agglomeration	**2020**				**2050**			
	RCP2.6	**RCP4.5**	**RCP6.0**	**RCP8.5**	**RCP2.6**	**RCP4.5**	**RCP6.0**	**RCP8.5**
Abidjan	11.7	12.2	12.3	14.0	36.1	38.9	39.3	46.9
Boston	0.7	1.2	1.3	3.0	20.5	23.3	23.7	31.3
Dubayy (Dubai)	2.8	3.3	3.4	5.1	24.7	27.4	27.9	35.4
Kolkata (Calcutta) (S)	19.6	20.1	20.1	21.8	72.6	75.4	75.8	83.1
New Orleans (S)	26.2	26.7	26.8	28.5	69.5	72.3	72.7	80.4
Tokyo (S)	0.0	0.0	0.0	0.0	33.7	36.5	37.0	44.3
Vancouver (S)	23.7	24.3	24.3	26.0	64.8	67.7	68.2	75.6

* (S) indicates that the city is subject to significant subsidence. The reference data are taken from Hallegatte et al. (2013).

The last step is to identify when adaptation should be taken (Table 2). In planning adaptation, it is important to know the right time to start to build defences. Previous works have suggested the use of adaptive policies that can be changed or adjusted in time (see, for example, Kwakkel et al. 2015). Precisely, the acceptable risk approach allows designing progressive adaptation strategies, which is achieved by analysing how expected shortfall changes every 5 years. Building up flexibility in decision-making for planning adaptation infrastructures is a great challenge, but it can be achieved by updating information as soon as assessments showing which IPCC scenario are closer to reality become available.

Table 2. Year in which cities should start adaptation based on RCP scenarios and different threshold of acceptable risk (extract from Skourtos et al., 2016).

Urban agglomeration	**0.1% damage**				**0.5% damage**				**1% damage**			
	2.6	4.5	6.0	8.5	2.6	4.5	6.0	8.5	2.6	4.5	6.0	8.5
	Year to start adaptation				Year to start adaptation				Year to start adaptation			
Boston	2010	2010	2010	2010	2015	2015	2015	2015	2025	2020	2020	2020
Dubayy (Dubai)	2010	2010	2010	2010	2015	2015	2015	2010	2015	2015	2015	2015
Kolkata (Calcutta)	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
New Orleans	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010
Tokyo	2010	2010	2010	2010	2025	2020	2020	2020	2025	2025	2025	2025
Vancouver	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010	2010

Main implications and recommendations

The use of acceptable risk involves similar information as is needed for a Real-Option Analysis– i.e. the value at risk and expected shortfall. The information can be used to estimate the current decisions on when it is optimal to undertake an investment and at what level to undertake it. To be sure this decision can change, the calculations can be taken at regular intervals and decisions revisited. This does not avoid the case where a previous decision to invest has already been taken and new information indicates that it would not have been taken if that information had already been present. Such cases, however, cannot be avoided under any system of decision-making.

The advantage of the methodological approach based on acceptable risk is that it allows political inputs to the process to be made relatively easily. The other advantage of this method is that it can be applied without too much difficulty, as the tools for its application are available. There is more scope for this approach to be applied in decision-making to take account of future learning and quasi-options values.

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Further Information
Future values for adaptation assessment: Report on treatment of future learning and quasi-option values
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