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Preliminary Concept Of Structured Expert Judgment Approach For Quantifying Uncertainty Of Future Sea Levels Along Dutch Coast

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Abstract

Climate change is expected to impact future sea levels along the Dutch coast due to regional mean sea level (RMSL) rise and potential changes in weather patterns at the North Sea basin. Projections indicate a continued increase of RMSL throughout the 21st century, with scenarios ranging from 4-8mm yr-1 and 6-23mm yr-1 by 2050 and 2100, respectively (KNMI, 2023). Potential changes in storm frequency and intensity may result in changing extreme surges and waves. The Dutch coast, characterized by its low-lying hinterland protected by dunes and hydraulic infrastructure, can be particularly vulnerable to these changes in sea levels. Thus, a comprehensive understanding of future sea levels is necessary to develop robust adaptation strategies (Haasnoot et al., 2020). In this paper, a preliminary proposal for a structured expert judgment approach is implemented and evaluated, to quantify the uncertainties associated with sea levels (including mean sea level, astronomical tides, and storm surge) along the Dutch coast, using Cooke's classical method. A total of four experts provided uncertainty judgments, and their performance was evaluated, allowing for the derivation of yearly maximum and yearly average sea level probability distributions for the future (2025-2050). The combined estimate of the experts resulted in a projected maximum sea level of NAP+3.25m in Vlissingen and a projected maximum difference of 7.4-20mm yr-1 in yearly-averaged sea levels for Hoek van Holland. The experts were more uncertain about the latter, which may be explained by the natural variability in sea levels, e.g. due to storm surges (Le Bars et al., 2019). This study is used to explore the feasibility of the proposed method for the estimation of future sea levels and their accompanying uncertainties. We show the potential of Cooke's method by providing a methodology that assists in enhancing the precision and applicability of climate change impact assessments for coastal regions such as the Netherlands.

Keywords: sea level rise, extreme sea levels, expert judgment, Cooke's classical method

1. Introduction

According to Robinson (2020), global mean sea level (GMSL) increased by approximately 0.20 meters from 1901 to 2018 with an accelerated rate since the 1960s (3.7mm yr^{-1} from 2006 to 2018). Due to global warming, GMSL will continue to rise, persisting for centuries, even after greenhouse gas (GHG) emissions cease. At regional scales, various factors influence local sea level changes relative to GMSL, resulting in spatial patterns that increase sea level rise at low latitudes and reduce it at high latitudes. However, over the 21st century, the majority of coastal locations will have a median regional sea level rise within ±20% of the projected GMSL change.

In the Netherlands, the Dutch Royal Meteorological Institute (KNMI) represents the country in the Intergovernmental Panel on Climate Change (IPCC). In their latest future climate scenario assessment (KNMI, 2023), the global IPCC climate projections are translated into the Dutch context. KNMI (2023) considers two emission scenarios (the IPCC SSP5-8.5 (Shared Socio-economic Pathway) and SSP1-2.6 scenario) and two scenarios for precipitation changes (wetter or drier climate). While the high emission scenario shows a sharp increase of emissions until 2080, the low emission scenario accomplishes the goals established by the Paris Climate Agreement. These scenarios result in four pathways that describe the future climate in the Netherlands around 2050, 2100, and 2150, for which a wide range of variables is considered, including regional mean sea level (RMSL) and storminess.

Regarding the RMSL, the future predictions by KNMI (2023) indicate a sea level rise of 16-34cm by 2050 in the low emission scenario and 19-38cm in the high emission scenario. In comparison, the present climate RMSL exhibited an increase rate of 1.7mm yr^{-1} until the early nineties when the rate accelerated to 2.7mm yr^{-1} (Steffelbauer et al., 2022). The latter is equivalent to an extrapolated regional sea level rise of around 8cm by 2050, half of the projection by the low emission scenario. Nonetheless, the future predictions of KNMI (2023) could even reach higher values if uncertain processes were considered such as the Antarctic ice sheet mass loss (Bamber et al., 2019).

Beside RMSL rise, global warming might induce changes in weather patterns, including storm intensity and frequency, and hence, changes in extreme surges and waves, consequently on regional extreme sea levels (RESL). Storm-induced ESL are the main cause of flood risk along the Dutch coast. The thermodynamic response of storms to a warmer climate is a complex process (Shaw et al., 2016) and changes in weather patterns can result in both an increased or decreased flood risk for coastal areas around the world. In contrast with future projections based on CMIP6, which generally show a small increase of storm surges for the North Sea (Muis et al., 2023), the KNMI predicts a slight decrease of the frequency of extreme north-western storms above the North Sea for the year 2100.

Overall, the magnitude of future RMSL rise in the Netherlands is sensitive to the scenario considered (KNMI, 2023), and even though current projections indicate a decrease in RESL, due to large uncertainty in climate models and unseen natural variability (Brunet et al., 2023), RESL events might still become more common by 2100 (Oppenheimer et al., 2019). Main uncertainties lie in the emission levels and the climate response to these scenarios. Understanding the impact of climate change on sea levels may help the population in coastal areas to prepare and adapt to the rising waters by allowing the development of robust infrastructure and flood control measures. Therefore an important step, towards safeguarding coastal areas through effective decision making regarding infrastructure and flood-risk management, is to address uncertainties related to RSLR and RESL.

In the AR6 IPCC six assessment report (IPCC, 2023), uncertainties are expressed qualitatively. According to Mastrandrea et al. (2010), a calibrated language is used for developing expert judgments and to evaluate and communicate the degree of certainty in findings of the assessment process. It relies on two metrics for communicating, i) confidence is expressed qualitatively, and ii) quantified measures of uncertainty in a finding expressed probabilistically. Therefore, uncertainty is “taken into account” by adding qualifiers such as “highly confident”, “most likely” and “virtually certain”. This approach presents a challenge in dealing with the societal impact of climate issues. Nevertheless, advances in quantitative assessments have been developed in the last years. For example, in Bamber et al. (2019), Cooke’s classical approach was used to address the uncertainties of future GMSL related to limitations in ice sheet projections under different temperature scenarios.

In this study, we employed a structured expert judgment approach, which consists of eliciting and combining expert judgments based on empirical control to reach rational consensus. Specifically, the Cooke’s classical method (Cooke & Goossens, 2008) was applied to quantitatively assess uncertainties related to RMSL and RESL along the Dutch coast. The goal of this study is to test the method on the subject of sea levels along the Dutch coast, and to evaluate how experts approach different type of questions related to this topic. The lessons-learnt from this study will be incorporated in the next phase of the study in 2024, when the methodology will be applied to a larger group of experts to determine probabilities associated with future sea levels along the Dutch coast.

The remainder of this paper is organized as follows. In Section 2, a brief description of the concepts and methodology regarding Cooke’s classical model and the respective questionnaire are described. The results and conclusions of this study are discussed in Section 3 and Section 4 respectively.

2. Cooke’s method for structured expert judgment

The classical model of structured expert judgment is a method for eliciting and combining expert judgments. Its goal is to treat expert judgment as scientific data (Cooke & Goossens, 2008). The method is particularly useful for situations in which too few data are available for reliable quantitative assessments of risk, e.g. extreme events or future climate. In such cases experts guidance is recommended (French et al., 2021). Experts are asked to provide their uncertainty regarding questions in their field of expertise for which true values are known (or will be known within the time frame of the research) in addition to uncertainty regarding questions of interest. These questions are called seed and target questions respectively (Cooke & Goossens, 2008). Within the time frame of the research, the true answer to the seed questions are known by the researchers but not by the experts. Target questions cannot be properly or timely assessed by data or models, therefore, expert judgment is needed. An extensive description of this methodology is presented in Cooke & Goossens (2008).

In Cooke's classical method, expert assessments are scored and weighted according to their calibration and information scores. First, for each seed or target question, experts are presented an uncertain quantity taking values in a continuous range and they give pre-defined percentiles. Following Cooke & Goossens (2008) in this study, experts are asked to provide the 5th, 50th, and 95th quantiles of their estimates. Next, the calibration score is derived from the seed questions while the information score is obtained from all questions. While the calibration score measures the statistical likelihood that a set of experimental results correspond (in a statistical sense) with the expert's assessments, the information score measures the degree of concentration of the distribution, which explains the degree of uncertainty of the estimates provided by the expert. A calibration score of one implies the best calibration, while a value of 0.05 is often used as the lower limit; a smaller value casts doubts about the statistical accuracy of the expert's estimates. For the information score, it holds that the larger the value, the better. The calibration and information scores are used to calculate performance-based weights $\omega(e)$, by multiplying the calibration and information scores. Finally, decision makers (DMs) emerge from the weighted sum of individual experts' uncertainty assessments. For each expert e and item (question) i, a probability density function (PDF) $f_{e,i}$ is derived from the estimated percentiles. The DM is represented by the equation:

$$DM(i) = \frac{\sum_e \omega(e) f_{e,i}}{\sum_e \omega(e)} \qquad (1)$$

This DM is known as the global DM because the weight factor is determined by all seed questions. Another variation is the DM based on item weights, achieved by substituting $\omega(e)$ in Eq. (1) with $\omega(e,i)$. In this scenario, experts exhibiting greater confidence in a specific question i carry more weight in the decision maker for the corresponding question, provided their calibration score is sufficiently large. The DM comprises all experts' PDFs, therefore, it inherently possesses an uncertainty estimate and, consequently, a weight. This weight can be optimized by excluding experts based on a calibration score threshold. Moreover, it is possible to allow the group to assign weights based on alternative criteria or to assign equal weights to all experts.

In this study, the experts' assessments were processed using software specialized on expert judgment based on Cooke's classical method: the open source, python-based software ANDURYL v1.2 (Rongen et al., 2020). ANDURYL is a program specifically designed for processing expert judgments based on Cooke's classical model, enhancing the precision and applicability of the assessment ('t Hart et al., 2019; Leontaris & Morales-Nápoles, 2018).

2.1. Questionnaire and experts

The questionnaire contained a total of 12 questions and a brief description of the location of interest and the method. Out of the 12 questions, the first 10 were the seed questions and the last two were the target questions. An overview of the sorts of seed questions is presented in Table 1. Example seed questions for both types and the two target questions are listed in Table 2 and Table 3. The seed questions were divided into two types, the first five questions were related to estimates of sea levels in terms of yearly maxima S_{max} (referred to as part 1), while the remaining five questions were related with differences in yearly-average sea levels between consecutive years S_t (part 2). All the seed questions require estimations for time periods between 1950 and 2015 for different locations along the Dutch coast (Vlissingen, Hoek van Holland, Den Helder, Delfzijl). The answers to the seed questions were derived from the GESLA-3 (Global Extreme Sea Level Analysis) dataset (Haigh et al., 2023). The target questions were used to elicit the yearly maximum sea level in m+NAP and the maximum difference in averaged sea level between consecutive years in m yr^{-1}, for the future period from 2025 to 2050. Yearly maxima give an indication about RESL, while maximum yearly differences are related to RMSL rise. In this study, RESL was composed of RMSL, tides and storm surges, since the sea levels were measured at tidal gauge stations sheltered of wave effects. In addition river run-off and steric components of sea level were not considered. However, in reality, drivers like waves, river run-off and the thermo- and halo-steric components can play a significant role on regional scales (Vinogradov & Ponte, 2011).

A total of four experts participated in the elicitation. All experts are affiliated to Delft University of Technology at the Hydraulic Engineering section in the Faculty of Civil Engineering, and have expertise in fields related to this study. The experts were contacted individually and were provided with an explanation of the Cooke's method and the phenomena (RMSL and RESL) by one of the authors. Then, the questionnaire was filled individually and independently. During the elicitation, the experts were allowed to ask questions about the method and the questionnaire. **Błąd! Nie można odnaleźć źródła odwołania.** presents the experts' names, occupations, and expertise. However, from now on the experts are labeled using letters from A to D. To keep answers anonymous the order in the table does not correspond with the labels.

Table 1. Overview of the seed questions.

Question	Variable	Quantity	Period of time	Location
1	S_{max}	minimum	1980-2000	Vlissingen
2	S_{max}	minimum	1980-2000	Hoek van Holland
3	S_{max}	minimum	1980-2000	Den Helder
4	S_{max}	minimum	1980-2000	Delfzijl
5	S_{max}	maximum	1950-1970	Vlissingen
6	$S_t - S_{t-1}$	maximum	1980-2015	Vlissingen
7	$S_t - S_{t-1}$	maximum	1980-2015	Hoek van Holland
8	$S_t - S_{t-1}$	maximum	1980-2015	Den Helder
9	$S_t - S_{t-1}$	maximum	1980-2015	Delfzijl
10	S_t	minimum	1950-2015	Delfzijl

Table 2. Two example seed questions, one for each type.

Example seed question	Variable
Consider all yearly maxima observations of sea level S_{max} [m+NAP] in Vlissingen for the years 1980 to 2000. Thus a total of 20 observations. What is the minimum value across these observations in m+NAP?	S_{max}
Consider the yearly mean sea level S_t [m+NAP] at Vlissingen for the years 1980 to 2015. Consider the difference in sea level between one year and the previous year ($S_t - S_{t-1}$). What is the maximum across these yearly differences in m?	$S_t - S_{t-1}$

Table 3. The two target questions.

Target questions	Variable
Consider all yearly maxima observations of sea level S_{max} [m+NAP] in Delfzijl for the years 2025 to 2050. Thus a total of 25 observations. What will be the maximum value across future these observations in m+NAP?	S_{max}
Consider the yearly mean sea level S_t [m+NAP] at Vlissingen for the years 2025 to 2050. Consider the difference in sea level between one year and the previous year ($S_t - S_{t-1}$). What will be the maximum across these yearly differences in m?	$S_t - S_{t-1}$

Table 4. Overview of the experts that participated in the elicitation, including their occupation and expertise.

Name	Occupation	Expertise
José Antonio Álvarez Antolínez	Assistant professor	Nature based solutions, coastal modeling, climate change
Cees Oerlemans	PhD candidate	Flood risk, climate change adaptation, sea level rise
Mia Pupić Vurilj	PhD candidate	Extreme sea levels, climatology, oceanography
Bart Strijker	PhD candidate	Flood risk, river catchments, polder systems

3. Results

An overview of the calibration and information scores are presented in Table 5 for the experts and in Table 6 for the resulting DMs. Overall, the results show that expert A and C perform the best. They have both a high information and high calibration score. The lower rows show the results for different DMs. The first indicator, the equal weight DM (DM_{eq}), defined as the average of the experts' estimates for each question, has a higher calibration score than each individual expert, and an information score lower than those of the individual experts. This can be explained by the fact that averaging leads to rather wide distributions. The second one, the (performance-based) global weight DM (DM_{gl}), which weighs experts based on their performance in the seed questions (Equation 1), gives the most weight to experts A and C (about 97%). In contrast with the DM_{eq}, both the information and the calibration score improve for the DM_{gl}. Note that, when optimizing the DM_{gl} based on the calibration score, the significance level α is such that no expert is excluded for the global weights, which explains the identical scores obtained with and without optimization.

The fourth indicator, the item weight decision maker (DM_{it}), uses the expert's weights per seed question, instead of the overall weight as the DM_{gl} does, thus, the information scores can differ per question resulting in different weights. The DM_{it} leads to the highest information and calibration scores. Applying optimization on the DM_{it} results in the exclusion of expert B and C, due to a significance level α=0.00599, which is equal to the calibration score of the second-best expert. The optimized DM_{it} results in a slightly higher information score, but the same calibration score in comparison to the DM_{it} without optimization. For further analysis, we only consider the DM_{eq}, the DM_{gl} (without optimization) and the optimized DM_{it_opt}.

Table 5. Calibration, information, and weights for the four experts.

	Information			
Experts	All questions	Seed questions	Calibration score	Weight
A	1.52	1.45	5.99×10^{-3}	8.68×10^{-3}
B	1.04	1.08	2.64×10^{-4}	2.85×10^{-4}
C	1.25	1.33	6.29×10^{-3}	8.36×10^{-3}
D	0.83	0.93	2.64×10^{-4}	2.46×10^{-4}

Table 6. Calibration and information scores for different decision makers.

	Information		
Decision makers (DM)	All questions	Seed questions	Calibration score
Equal weight DM (DM_{eq})	0.13	0.13	0.29
Global weight DM without optimization (DM_{gl})	0.54	0.52	0.47
Global weight DM with optimization (DM_{gl_opt})	0.54	0.52	0.47
Item weight DM without optimization (DM_{it})	1.03	1.04	0.24
Item weight DM with optimization (DM_{it_opt})	1.07	1.09	0.24

To illustrate differences in the estimates of the four experts, Fig. 1 shows the results for two seed questions as examples (one from part 1 and one from part 2). The results are shown in terms of a cumulative distribution function (CDF). The figure shows that expert A is more certain about their answer to the question in Fig. 1b (about yearly differences), than for the question in Fig. 1a. The DM_{gl} is mainly determined by expert A (dark blue line) and C (dark orange line), and lies in between those two lines. The same holds for the DM_{it_opt}, but it tends more towards the expert with a higher information score (i.e. steeper CDF between 0.05 and 0.95) for the corresponding question. It can be seen that the DM_{eq} is an average of all experts.

Fig. 2 presents the results for the two target questions, regarding yearly maximum and averaged sea level for the future. The figure illustrates that the uncertainty of the answer to the second target question is larger than for the first, and the differences between DMs are larger. For the yearly maximum (Fig. 2a), the DM_{gl} and the DM_{it_opt} give very similar results, approximately NAP+3.25 m for the 50th quantile, and the 95% confidence interval between NAP+2.8m and NAP+4.0m. Regarding the maximum yearly difference (Fig. 2a), the assessments of expert A and C, who are the most dominant for the performance-based DMs, show larger deviation. It results in values of 20mm yr^{-1} and 7.4mm yr^{-1} for the 50th quantile of the DM_{gl} and DM_{it_opt}, respectively, for the maximum yearly difference in average sea level. The 95% confidence interval is similar for both DMs, approximately between 3mm yr^{-1} and 95 to 135mm yr^{-1}, implying that the uncertainty is large.

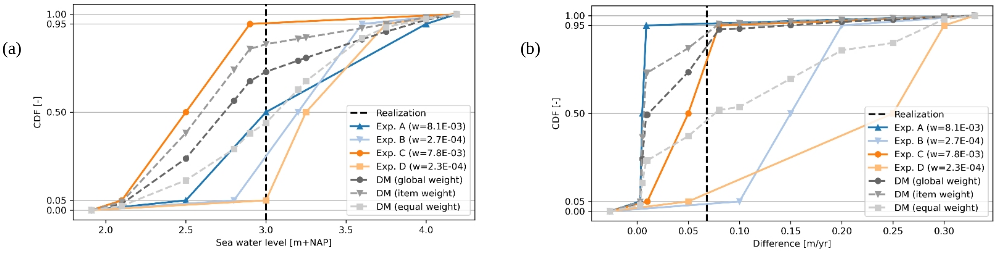

Fig. 1. Experts' and DMs' estimates for two seed questions: (a) Question 5: What is the minimum of the yearly maximum sea levels for 1950-1970 in Vlissingen?; (b) Question 6: What is the maximum difference in yearly-averaged sea levels for consecutive years for 1980-2015 in Vlissingen? The x-axis shows the value that is asked in the question and the y-axis the corresponding value in the CDF. The experts' estimates (based on the 5th , 50th and 95th quantile) are shown by the colored lines with markers at their estimated values. The estimates based on the DMs are shown in grey dashed lines. The vertical dashed line shows the realization.

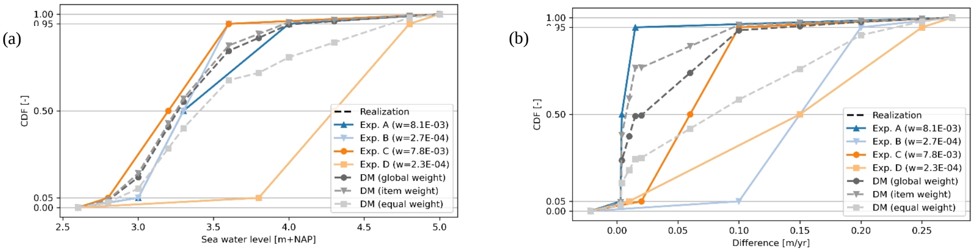

Fig. 2. Experts' and DMs' estimates for the two target questions: (a) Question 11: What is the maximum of the yearly maximum sea levels for 2025-2050 in Hoek van Holland?; (b) What is the maximum difference in yearly- averaged sea levels for consecutive years for 2025-2050 in Vlissingen? The x-axis shows the value that is asked in the question and the y-axis the corresponding value in the CDF. The experts' estimates (based on the 5th , 50th and 95th quantile) are shown by the colored lines with markers at their estimated values. The estimates based on the DMs are shown in grey dashed lines.

As mentioned in Section 2.1, there are two different types of questions: part 1 about yearly-maximum sea levels and part 2 about differences in yearly-averaged sea levels. When considering the calibration of the expert's assessments for these two question types, it turns out that their performance is in general much better for part 1 on yearly-maximum sea levels. This is illustrated in **Błąd! Nie można odnaleźć źródła odwołania.**. These histograms show the number of true answers to the seed questions within each of the four quantile intervals of the experts' estimates. The different colors represent the different experts. The left figure concerns the questions from part 1, which are five in total, and the right figure about part 2, which are in total four questions (the tenth question was about an absolute value of yearly averages, instead of differences). The figure shows that the calibration is better for part 1, since the answers are better distributed over the four quantile intervals, at least for the experts A and C. For the questions from part 2, most experts either consistently overestimate (expert A and C) or underestimate (Expert B).

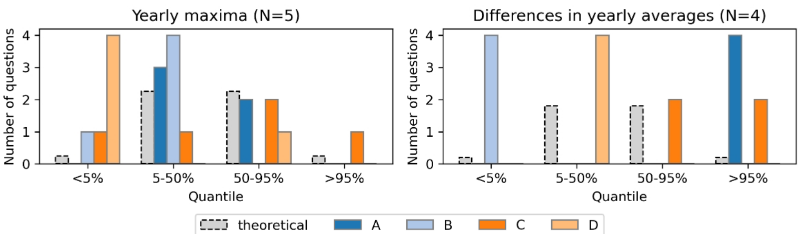

Fig. 3. Overview of the experts' calibration for the two types of questions. The x-axis represents the four quantile intervals from the experts' estimates, in which the true answer to a seed question can fall. The y-axis shows the number of seed questions for which the true answer falls within the corresponding quantile interval. The different colored bins correspond to the different experts. The grey-colored bin represents the theoretical statistically accurate distribution of the answers. The figure in the left panel shows these numbers for the N seed questions about yearly-maxima (N=5) and the right panel for the four seed questions about differences in yearly-average sea levels.

3.2. Applicability for estimating sea level probabilities

The combined estimate of the experts' assessments to the 50th quantile for the target questions result in a maximum sea level of around NAP+3.25 m in Hoek van Holland for the future period 2025-2050, based on the DM_{gl} and the DM_{it_opt}. This value is close to the average of the yearly-maxima from 1950 to 2018, which is NAP+3.34 m. Based on this, it can be concluded that the experts do not expect a change in yearly-maximum sea levels for the future period. This is in line with the results from KNMI (2023). Regarding the changes in yearly-averaged sea levels for the future period, the 50th quantiles of the DM_{gl} and the DM_{it_opt} are equal to 20 and 7.4 mm yr^{-1} for Vlissingen, including a large uncertainty. Compared to the historical period, most experts estimated values in the same order of magnitude, although some experts project a slight increase, especially in the 95th quantile.

According to the KNMI (2023), the projected sea level rise until 2050 is about 16-34 cm for the SSP1-2.6 emission scenario, and up to 19-38 cm for SSP5-8.5, as illustrated in **Błąd! Nie można odnaleźć źródła odwołania.**. These values correspond to a rise of 6-12.5 mm yr^{-1} and 7-14 mm yr^{-1} respectively, considering the period 2023-2050, so a slightly smaller value than from this study. However, for RMSL, the comparison to the KNMI future projections is rather difficult. Within the study of this paper, the experts estimated changes in *yearly-averaged sea levels*, which included variability due to extremes in one year compared to the other, implying that the data contains a lot of noise, e.g. due to storm surges. In contrast, the KNMI projections consider the *mean sea level* rise, in which a correction due to natural variability of wind is applied.

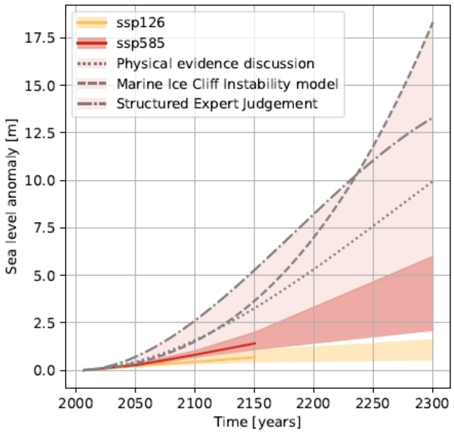

Fig. 4. Projected future increase in sea-level at the Dutch coast until 2300 for the SSP1-2.6 and SSP5-8.5 emission scenarios (KNMI 2023). The median is only shown up to 2150, the 17th to 83rd percentile range are shown. Grey lines represent the LPHI scenarios.

4. Discussion and conclusions

This study presents a structured expert judgment approach following the Cooke's method involving four experts with a background in hydraulic engineering to assess the uncertainties to yearly maximum and yearly averaged sea level uncertainties for the future (2025-2050) in the Dutch coast. The combined estimate from experts (which constitute the decision maker) results in a value of approximately NAP+3.25 m for the 50th quantile of the maximum sea level for the period 2025-250 in Vlissingen. Regarding the yearly differences, the combined estimate a maximum difference of about 7.4 to 20 mm yr^{-1} for the yearly-averaged sea levels for the future period in Hoek van Holland. The latter includes a larger uncertainty estimate than the first target variable.

When compared to the historical period from 1950 to 2018, the results show that the experts do not expect a significant change in yearly-maximum sea levels and in yearly-averaged sea levels for the future period 2025 to 2050. This is consistent with KNMI'23 projections regarding the extremes (which are related to storm frequency and intensity). However, the elicitation of the yearly-averaged sea levels cannot be compared to the KNMI (2023) projections since they consider the mean sea level rise.

The main objective of the current study was to test the proposed method of Structured Expert Judgment for this specific topic of future sea levels along the Dutch coast. This includes an evaluation of the type of questions, the provided information to the experts, and the experts itself. Regarding the type of questions, the results in Section 3 showed that experts have a higher calibration score for estimating yearly-maximum sea levels than for estimating changes in yearly-averaged sea levels. This discrepancy might have various causes. First, part 2 of the questions deals with yearly-averaged sea levels, which might contain a lot of noise due to natural wind fluctuation (Section 3.2). Therefore, experts may have difficulty estimating this variable. Furthermore, is key to consider that some of the experts may have preconceived estimations related to mean sea level rise, which could influence their assessment of averaged sea levels (these are not the same quantities). For this reason, it is recommended for the next phase of the study to make a clear distinction between questions related with mean sea levels and surge heights.

Deriving these quantities from measured data may pose a challenge, however the KNMI data may be used for this in some way. Regarding the provided information, experts indicated that they would benefit from additional information regarding sea levels along the Dutch Coast. For example, details about the different sea level components (tidal signal, surge heights etc.) at the different locations. Finally, it is recommended to increase and diversify the amount of experts. In the current study, only experts from the Delft University of Technology have been elicited, while this group should be extended for the follow-up study, to include researchers from other institutes and with different backgrounds.

Follow-up research would benefit from eliciting the diverse contributions of factors like glacial melt and thermal expansion to sea levels in the Dutch coast. Expanding the pool of experts, particularly including those with expertise in glaciology and oceanography, can provide a more comprehensive understanding of sea level in the future. It is suggested to incorporate questions about the estimated timelines for specific sea levels, as this temporal insight is crucial for implementing timely and effective flood mitigation strategies along the Dutch coast.

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