TWG1: Managing uncertainties
Simplified approach to elicitation of expert judgement in quantification of uncertainty

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Introduction

- UK regulatory guidance requires uncertainties to be quantified, and implies probabilistic calculations of risk will form part of a post-closure performance assessment.
- Quantification of uncertainty in parameter values as probability density functions (PDFs) can require expert elicitation.
- There are natural cognitive biases in estimating uncertainty, including a (strong) over-confidence bias.
- Formal, facilitated group elicitation methods in which experts are asked to come to a consensus in generating a PDF are effective, but resource intensive.
- RWM is considering a tiered approach.
Tiered approach to elicitation

- **Level 1**: Individual Elicitation
  - Low or unknown Impact
  - Low Information

- **Level 2**: Informal Group Elicitation
  - Low or unknown Impact
  - High Information
  - Low Impact

- **Level 3**: Formal Group Elicitation
  - High Impact
  - High Information
Uncertainty Quantification Form

Name of uncertain parameter: Length of River Severn
Units/currency: miles

Intuitive estimate of the quantity (to 1 sig fig):

Intuitive estimate of uncertainty (a factor of):

150
2

Part A
Complete the pale blue cells above.

1. Enter the name of the uncertain parameter.
2. Enter the units of measurement or currency for the parameter.
3. Give an intuitive estimate of the value of the parameter to a single significant figure.
4. Give an intuitive estimate of the amount of uncertainty that there is. This should be in the form of e.g. factor of 1.5, factor of 2, factor of 10, factor of 1000 etc. So it will be a number greater than 1.

When this is completed the form will allow you to complete Part B.

• Example using the ‘Level 1’ tool to quantify the uncertainty in the “Length of the River Severn” in England
• Enter an intuitive best estimate for the parameter value
• Enter an estimate of the uncertainty (i.e. a factor of...)
A scale for quantifying the uncertainty is proposed

The scale extends significantly above and below the intuitive best estimate (now blacked out)

The scale consists of rounded numbers equally spaced on a logarithmic scale

A logarithmic scale is appropriate for quantifying most uncertainties (unless the range crosses zero)
Uncertainty Quantification Form

Part A

1. Enter the name of the uncertain parameter.
2. Enter the units of measurement or currency for the parameter.
3. Give an intuitive estimate of the value of the parameter to a single significant figure.
4. Give an intuitive estimate of the amount of uncertainty that there is. This should be in the form of e.g. factor of 1.5, factor of 2, factor of 10, factor of 1000 etc. So it will be a number greater than 1.

When this is completed the form will allow you to complete Part B.

Part B

Ignore the intuitive estimates you gave in Part A (they should now be blocked out). A scale should appear at the left. Complete the form by filling in 5 steps:

1. Consider all sources of uncertainty for the parameter - if it helps, note them in the blue boxes on the right.
2. What sources of uncertainty haven't you thought of?
3. What would be a very high value for the parameter? How might this value arise? Working up the scale, select the first value that is virtually impossible. Are you sure? Put an X in the green box immediately above that value.
4. What would be a very low value for the parameter? How might this value arise? Working down the scale, select the first value that is virtually impossible. Are you sure? Put an X in the green box immediately below that value.
5. Imagine you have 100 casino chips. You need to distribute these betw een the green boxes between the two X’s, in proportion to the % probability of the parameter value lying between the numbers above and below each box.

When you have finished, a 'cumulative distribution function' for the logarithm (to base 10) of the parameter will appear at the right.

A graphical representation of your distribution will appear at the far right - review this and make any adjustments if necessary. When you are finished, record the date, names of expert(s) and any useful notes in the blue boxes to the right.

Consider the extreme values first

Put an ‘X’ in the box above the highest value that is possible

Put an ‘X’ in the box below the lowest value that is possible

Now imagine you have 100 casino chips – distribute these in the green boxes between the two X’s, in proportion to the % probability of the parameter value lying between the numbers above and below each box.
**Uncertainty Quantification Form**

Name of uncertain parameter: Length of River Severn

Units/currency: miles

Intuitive estimate of the quantity (to 1 sig fig): $1.50E+02$

Intuitive estimate of uncertainty (a factor of): 2

**Part A**

Complete the pale blue cells above.

1. Enter the name of the uncertain parameter.
2. Enter the units of measurement or currency for the parameter.
3. Give an intuitive estimate of the value of the parameter to a single significant figure.
4. Give an intuitive estimate of the amount of uncertainty that there is. This should be in the form of e.g. factor of 1.5, factor of 2, factor of 10, factor of 1000 etc. So it will be a number greater than 1.

When this is completed the form will allow you to complete Part B.

**Probability Log(value)**

<table>
<thead>
<tr>
<th>Value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>1.93</td>
</tr>
<tr>
<td>0.05</td>
<td>2.01</td>
</tr>
<tr>
<td>0.20</td>
<td>2.09</td>
</tr>
<tr>
<td>0.40</td>
<td>2.18</td>
</tr>
<tr>
<td>0.65</td>
<td>2.26</td>
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<tr>
<td>0.85</td>
<td>2.34</td>
</tr>
<tr>
<td>0.97</td>
<td>2.43</td>
</tr>
<tr>
<td>1.00</td>
<td>2.51</td>
</tr>
</tbody>
</table>

**Chips remaining to place:** 0

- Chips distributed as shown
- A CDF of the logarithm of the quantity results
- A chart illustrating the distribution is shown
Areas of potential research

• RWM would like to trial use of this tool, as part of a tiered methodology for quantifying uncertainty:
  – To identify areas where the tool can be improved
  – To obtain feedback on how intuitive and effective experts find it
  – To gain an understanding of potential accuracy of the tool…
  – …by quantifying uncertainty on things that can be known (e.g. weather statistics)
  – To confirm the tool fares better (statistically) than simply asking experts to give an uncertainty range directly

• Could be done as part of IGD-TP uncertainty activity (JA8)
  – International collaboration would give wider exposure and provide a larger dataset for analysis