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

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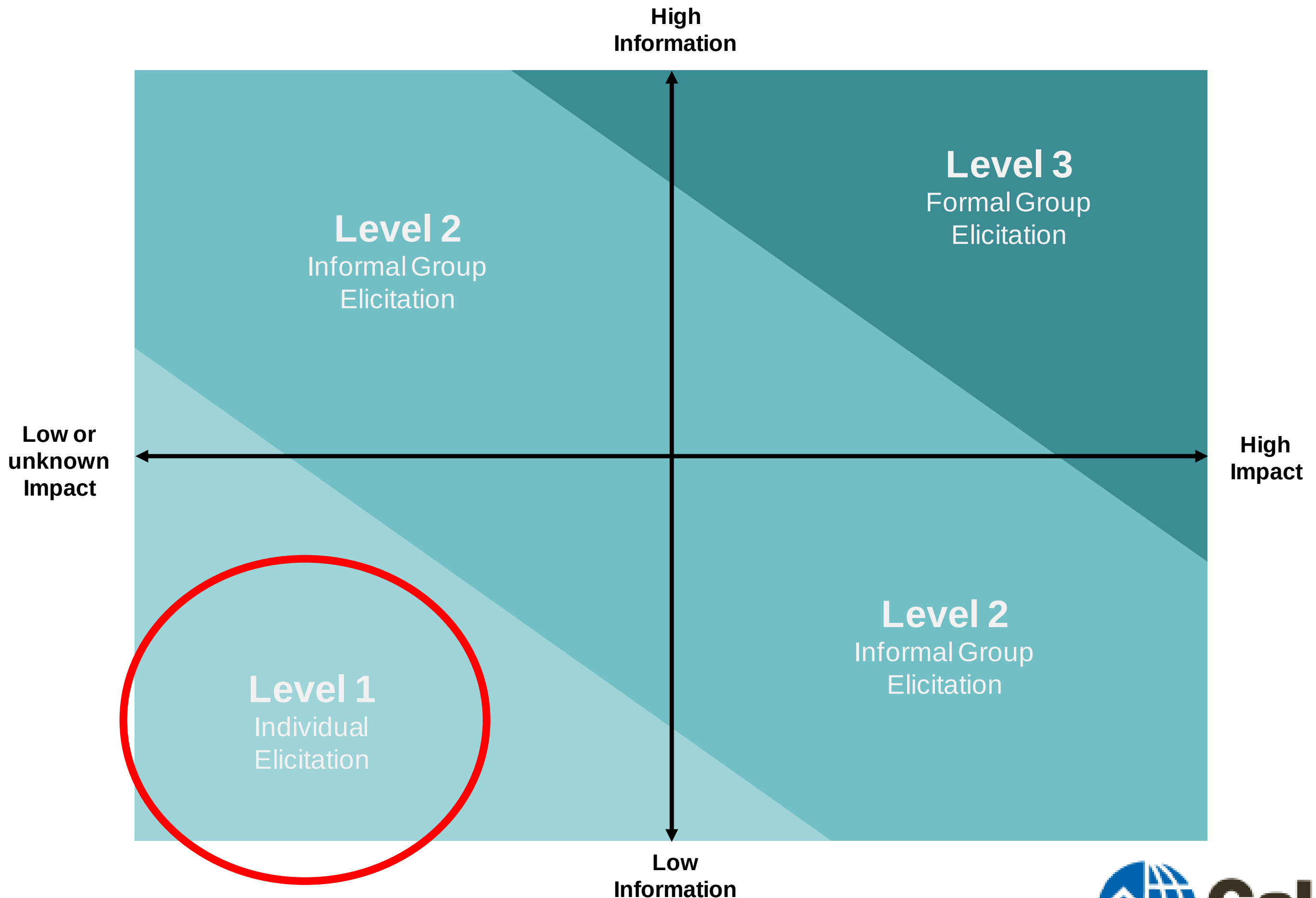
Introduction

- 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



Uncertainty Quantification Form

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

Intuitive estimate of the quantity (to 1 sig fig):	150
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.

- **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…)**

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Uncertainty Quantification Form

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

Intuitive estimate of the quantity (to 1 sig fig): [redacted]
Intuitive estimate of uncertainty (a factor of):

1,200 miles
1,000 miles
800 miles
700 miles
550 miles
450 miles
390 miles
320 miles
270 miles
220 miles
180 miles
150 miles
120 miles
100 miles
80 miles
70 miles
55 miles
45 miles
39 miles
32 miles
27 miles
22 miles
18 miles
15 miles

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.

Chips remaining to place: **100**

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 following 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 between the green boxes that lie between the two X's in proportion to the liklihood of the parameter value lying between the values above and below each box. Work your way alternatively from the two X's towards the middle of the range, entering a number of chips in each of the green boxes.

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.

- **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

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

Intuitive estimate of the quantity (to 1 sig fig): [redacted]
Intuitive estimate of uncertainty (a factor of):

1,200 miles
1,000 miles
800 miles
700 miles
550 miles
450 miles
390 miles
X
320 miles
270 miles
220 miles
180 miles
150 miles
120 miles
100 miles
80 miles
X
70 miles
55 miles
45 miles
39 miles
32 miles
27 miles
22 miles
18 miles
15 miles

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.

Chips remaining to place: 100

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 following 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 between the green boxes that lie between the two X's in proportion to the liklihood of the parameter value lying between the values above and below each box. Work your way alternatively from the two X's towards the middle of the range, entering a number of chips in each of the green boxes.

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

1,200 miles	
1,000 miles	
800 miles	
700 miles	
550 miles	
450 miles	
390 miles	X
320 miles	3
270 miles	12
220 miles	20
180 miles	25
150 miles	20
120 miles	15
100 miles	5
80 miles	X
70 miles	
55 miles	
45 miles	
39 miles	
32 miles	
27 miles	
22 miles	
18 miles	
15 miles	

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.

Chips remaining to place: 0

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 following 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.
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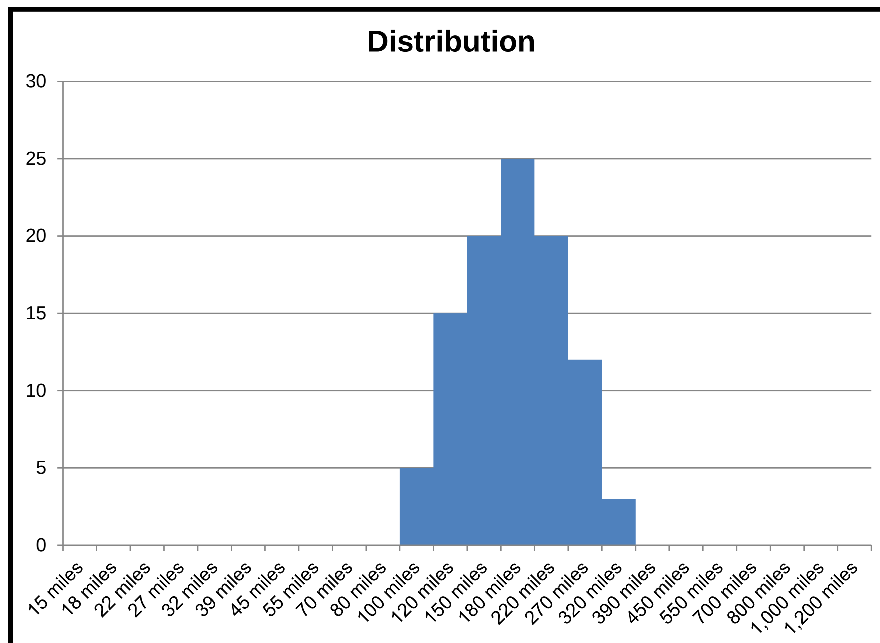
Probability	Log(value)
0.00	1.93
0.05	2.01
0.20	2.09
0.40	2.18
0.65	2.26
0.85	2.34
0.97	2.43
1.00	2.51

- **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