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Decision Making in Uncertainty Lab

Deltares & Universiteit Leiden

Jan Verkade and Margreet van Marle, Deltares

Thursday, November 10, 2022

Flooding

Weather patterns may lead to flooding in February, Met Office warns

Government embarks on campaign to raise awareness over weather threat as England remains in drought

Helena Horton
Environment reporter

Mon 7 Nov 2022 13.22 GMT

England had a relatively dry winter last year but in February it was battered by extreme storms. Photograph: Christopher Furlong/Getty Images

Global weather patterns may lead to severe flooding in February despite England remaining in drought, the Met Office has said.

Two-thirds of people at risk of flooding were unaware of the situation, the government said on Monday, as it embarked on an awareness campaign. This average cost to a flooded household is £30,000, figures show.

The end-of-winter floods would be a result of a weather phenomenon called La Niña - a powerful pattern influenced by cooler temperatures in the Pacific. This is what caused flooding in February, when storms damaged hundreds of homes.

Go to **www.menti.com** and use the code **63 74 03 3**

What is, according to the UK Met Office, the probability of flooding in February?

Mentimeter

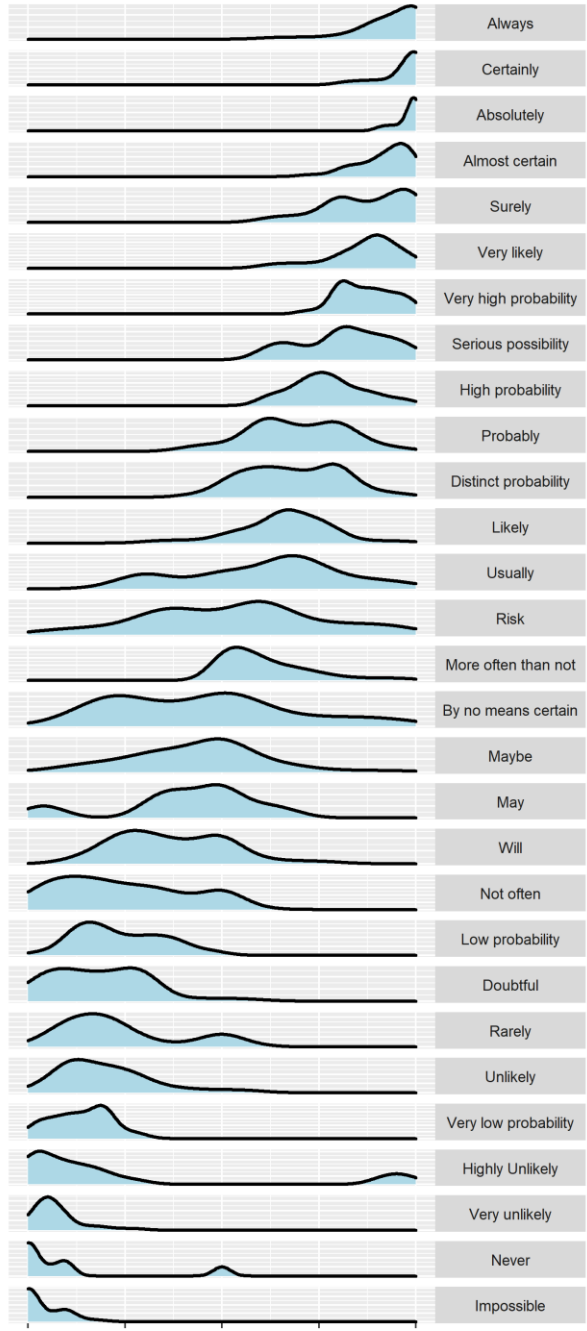
Weather patterns may lead to flooding in February, Met Office warns

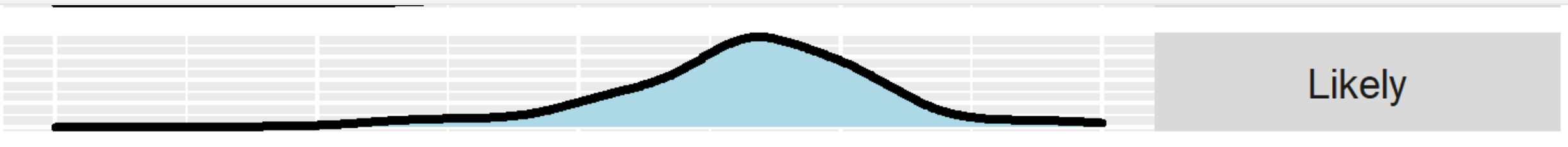
Government embarks on campaign to raise awareness over weather threat as England remains in drought

Look at your phone!

Words of estimative probability

n = 7




Likely

So what? and Now what?

- The purpose forecasting is to estimate and communicate what we know about the future
- That future is uncertain
- We use words of estimative probability to describe the level of that uncertainty
- But we don't always realise that a recipient may interpret our message differently from how we intended it
- And the alternative interpretation may result in a very different decision
- → this is called *noise*: variability where it is undesirable
- Noise is nearly always undesirable
  - For escalation or warning, it shouldn't matter which forecaster is on duty
  - Noise does <u>not</u> average out:
    one false alarm and one missed flood
    do not average to 'okay'

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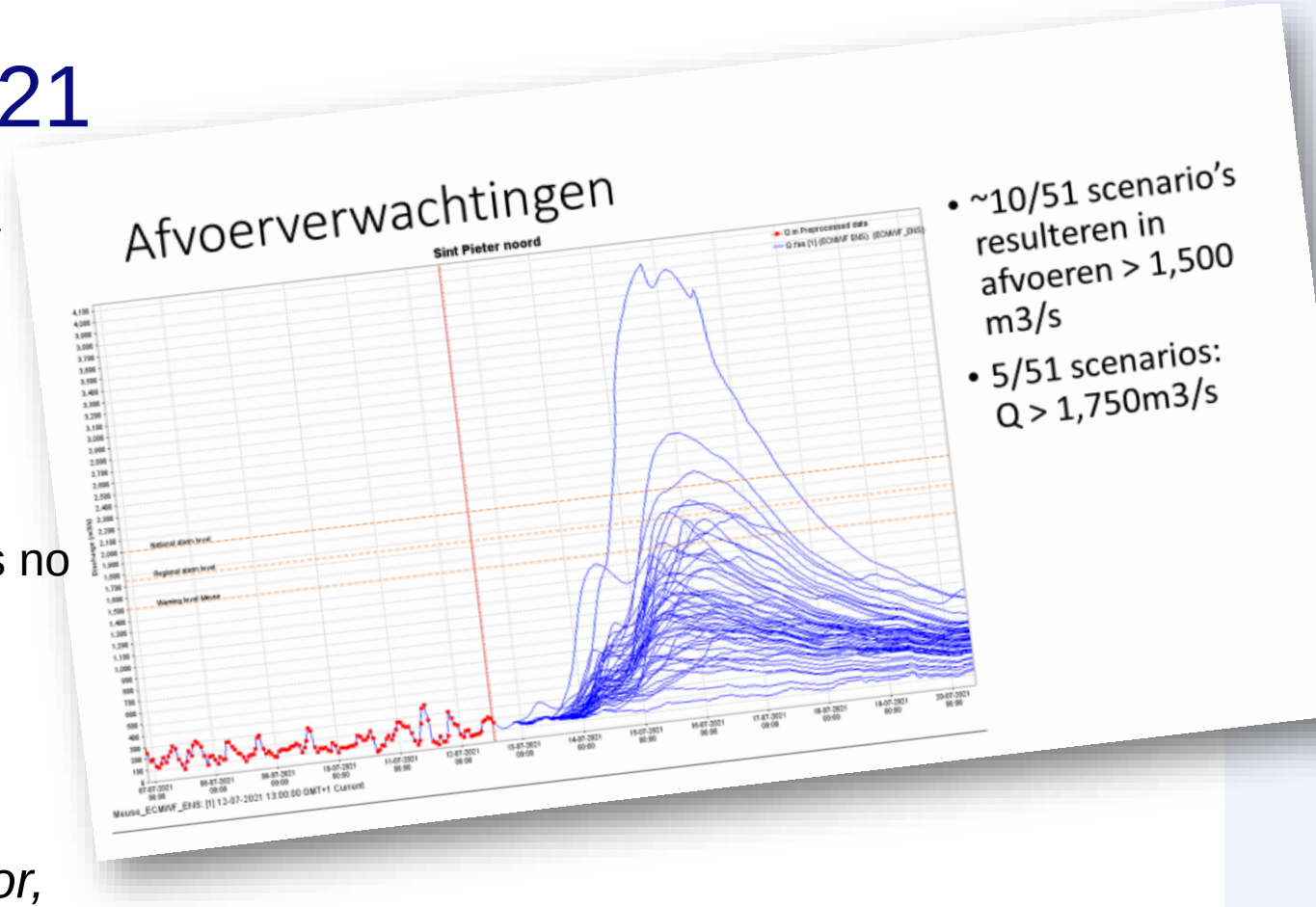
Bias. Monday, July 12, 2021

- River Meuse forecasts indicate unusually high flow rates
- First meeting with emergency response organization
  - “Nothing shows on the precipitation radar”
  - “The [upstream] government website gives no indication of flooding”
- → Active attempts to downplay the seriousness of the situation
- Possible explanation: *confirmation bias* “*the tendency to search for, interpret, favor, and recall information in a way that confirms or supports one's prior beliefs or values*”*



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* https://en.wikipedia.org/wiki/Confirmation_bias

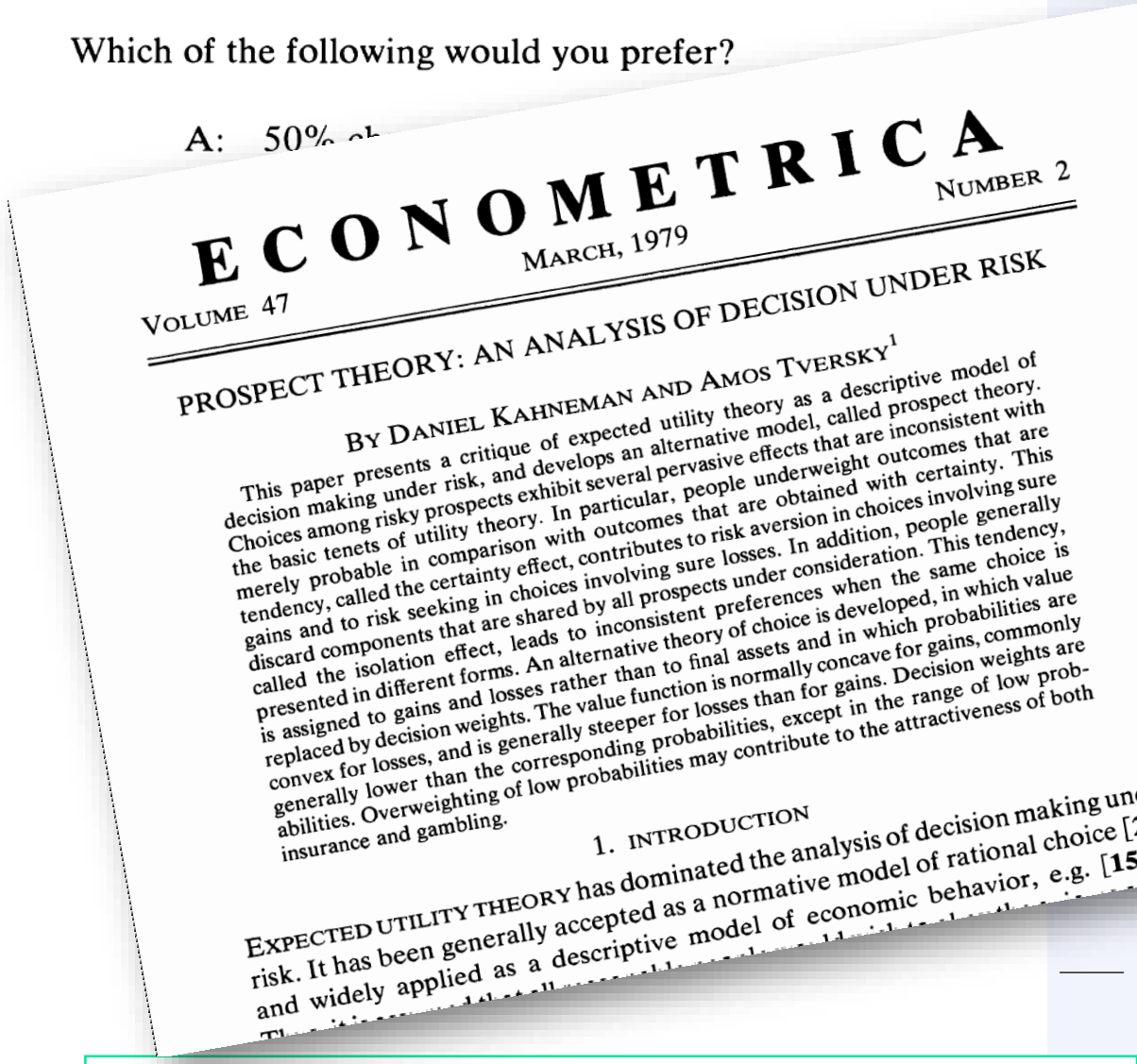
Which of the following would you prefer?

A: 50% chance to win 1,000,
50% chance to win nothing;

B: 450 for sure.

“Prospect theory”

- Expected value
  - A: 50% x 1,000 + 50% x 0 = 500
  - B: 100% x 450 = 450
- Yet most people choose B over A
- Observed decision making can be inconsistent with ‘rational’ decision making
- This, too, is a *bias*
- *Certainly* gets disproportionally higher weight than *possibly*
  - certain *gain* → risk averse behaviour
  - certain *loss* → risk seeking behaviour
- Context matters (Bill Gates may decide differently than we do)


Which of the following would you prefer?

A: 50% ch

ECONOMETRICA

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PROSPECT THEORY: AN ANALYSIS OF DECISION UNDER RISK

BY DANIEL KAHNEMAN AND AMOS TVERSKY[1]

This paper presents a critique of expected utility theory as a descriptive model of decision making under risk, and develops an alternative model, called prospect theory. Choices among risky prospects exhibit several pervasive effects that are inconsistent with the basic tenets of utility theory. In particular, people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty. This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses. In addition, people generally discard components that are shared by all prospects under consideration. This tendency, called the isolation effect, leads to inconsistent preferences when the same choice is presented in different forms. An alternative theory of choice is developed, in which value is assigned to gains and losses rather than to final assets and in which probabilities are replaced by decision weights. The value function is normally concave for gains, commonly convex for losses, and is generally steeper for losses than for gains. Decision weights are generally lower than the corresponding probabilities, except in the range of low probabilities. Overweighting of low probabilities may contribute to the attractiveness of both insurance and gambling.

1. INTRODUCTION

EXPECTED UTILITY THEORY has dominated the analysis of decision making under risk. It has been generally accepted as a normative model of rational choice [2] and widely applied as a descriptive model of economic behavior, e.g. [15

https://scholar.princeton.edu/sites/default/files/kahneman/files/prospect_theory.pdf

Wednesday, July 14, midday flood bulletin

Watermanagementcentrum Nederland
Team Expertise Maas (TEM)
WMCN Rivieren

woensdag 14 juli 2021 / nummer S01

Statusbericht Maas (afvoerverwachting St. Pieter)

Kleurcode GROEN

	Afvoer [m^3/s]	Tijdstip
Huidige (gemeten) afvoer St. Pieter	875 m3/s	wo 14-07-2021 11:00
Verwachte afvoer St. Pieter (+12 uur)	1450 m3/s	do 15-07-2021 00:00
Verwachte afvoer St. Pieter (+24 uur)	2475 m3/s	do 15-07-2021 12:00
Verwachte afvoer St. Pieter (+36 uur)	2400 m3/s	vr 16-07-2021 12:00
Maximum verwachte afvoer en waterstand St. Pieter (binnen 48 uur)	2750 m3/s	do 15-07-2021 20:00
Onzekerheid verwachte maximale afvoer St. Pieter (binnen 48uur)	1500 – 2500 m3/s (90% interval)	do 15 juli 12:00 – vr 16 juli 12:00

“Can you withdraw the flood bulletin?”


Statusbericht

Two possible explanations

- *Confirmation bias*: conviction that there will not be a flood mid July
- Risk seeking behaviour
  - certainty that escalation would result into hassle
  - while, at that time, flood occurrence was uncertain
  - → certainty receives higher weight

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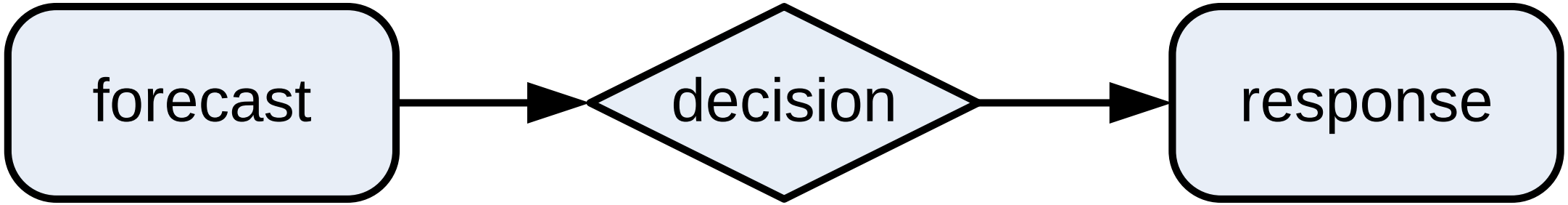
Enter the *Decision Making in Uncertainty Lab*

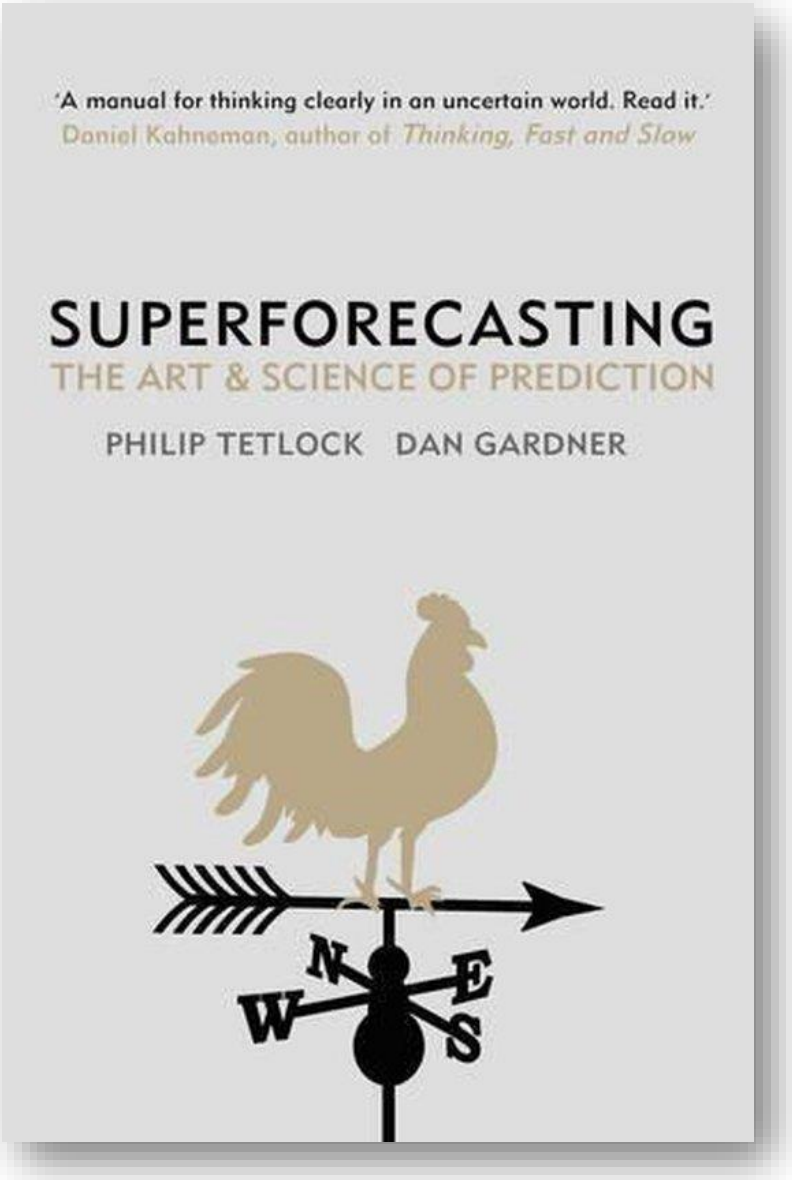
- Context: *forecast, decision, response* chain
- Scope:
  - Human forecast-informed decision making / judgment [bias, noise]
  - Subjective forecasting
  - Management of predictive uncertainty



Superforecasters in our forecasting rooms?

“Superforecasting”

- Forecasts of a social-political-economic nature:
  - “*What is the probability that, on January 1, 2023, Vladimir Putin will no longer hold the position of president of the Russian Federation?*”
- Multiple participants, multiple questions, option to adjust/modify responses
- Responses are scored using Brier’s probability score
- After some years: some forecasters are consistently better than others
- Why is that?
- Can we apply lessons learnt in hydrometeorology?



What makes a “superforecaster”?

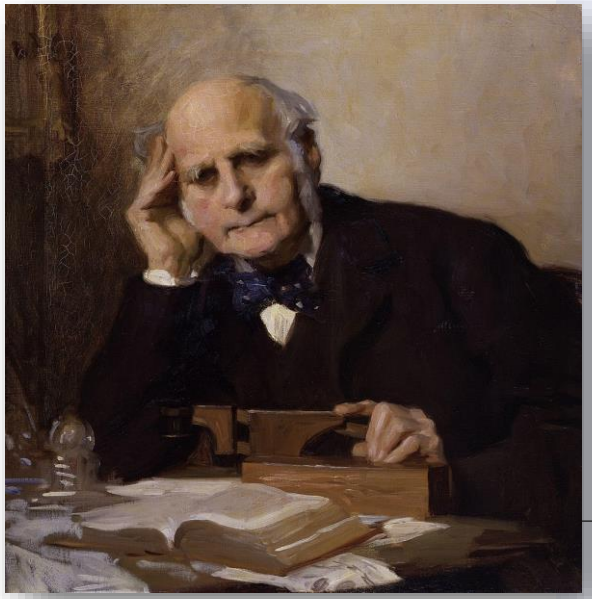
- Approach
  - Break up the problem in small pieces
    Fermi-izing: how many piano tuners are there in Chicago?
  - Take the outside view; no problem is truely unique
  - While balancing this with the inside view
  - Modify correctly: not too much, not too little
- Attitude
  - Do not be afraid to change your opinion
  - “Rigurous verification”, also in case of a ‘good’ forecast
  - Identify multiple perspectives:

    - re-assess the problem at a later stage.
    - Even better: force yourself to make an assessment that is as different as possible from the earlier assessment.
    - Best: ask somebody else, too.

“Superforecasters”: cooperation in groups

- Some groups perform much better than individuals → wisdom of the crowd
- Others perform much worse→ *group think*
- Key: group dynamics
  - Who speaks first?
  - Are opinions public?
  - …

  → requirement: *independent* judgments



Sir Francis Galton

by Charles Wellington Furse (died 1904). Source: wikimedia.org

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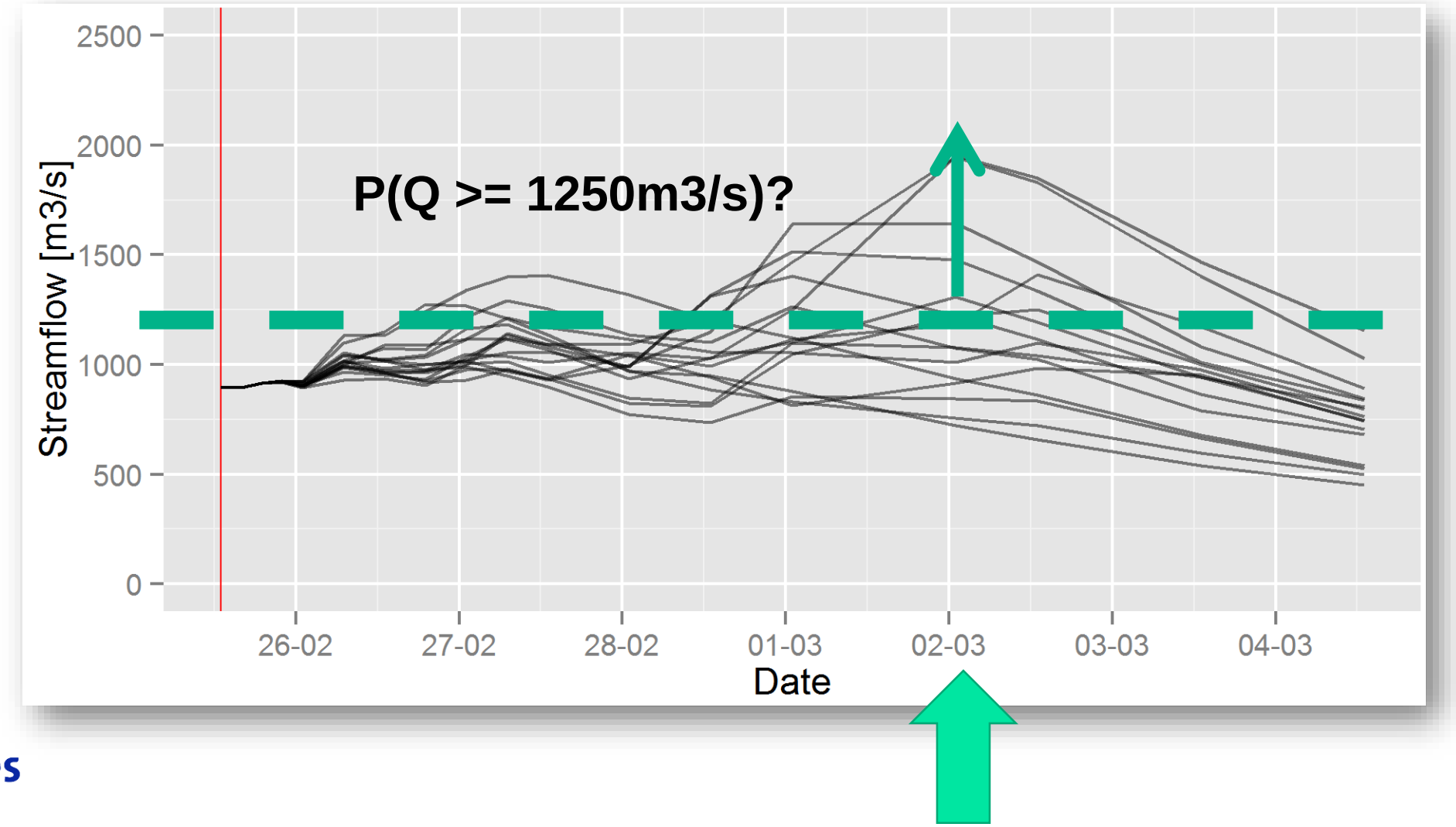
“Superforecasters” in our forecasting rooms?

- Training in soft skills:
  - change ones opinion when the facts justify doing so
  - find multiple perspectives, even when you’re working solo
  - cooperate in groups: strive for *wisdom of the crowd*, instead of *group think* *(*respectful disagreement)
- Role of verification: how does that lead to better forecasts?
  - Where was my reasoning right / wrong? How should I do that on a next occasion?
- ...

Management of predictive uncertainty

What is the probability that the March 2 streamflow rate will exceed 1,250 cumecs?



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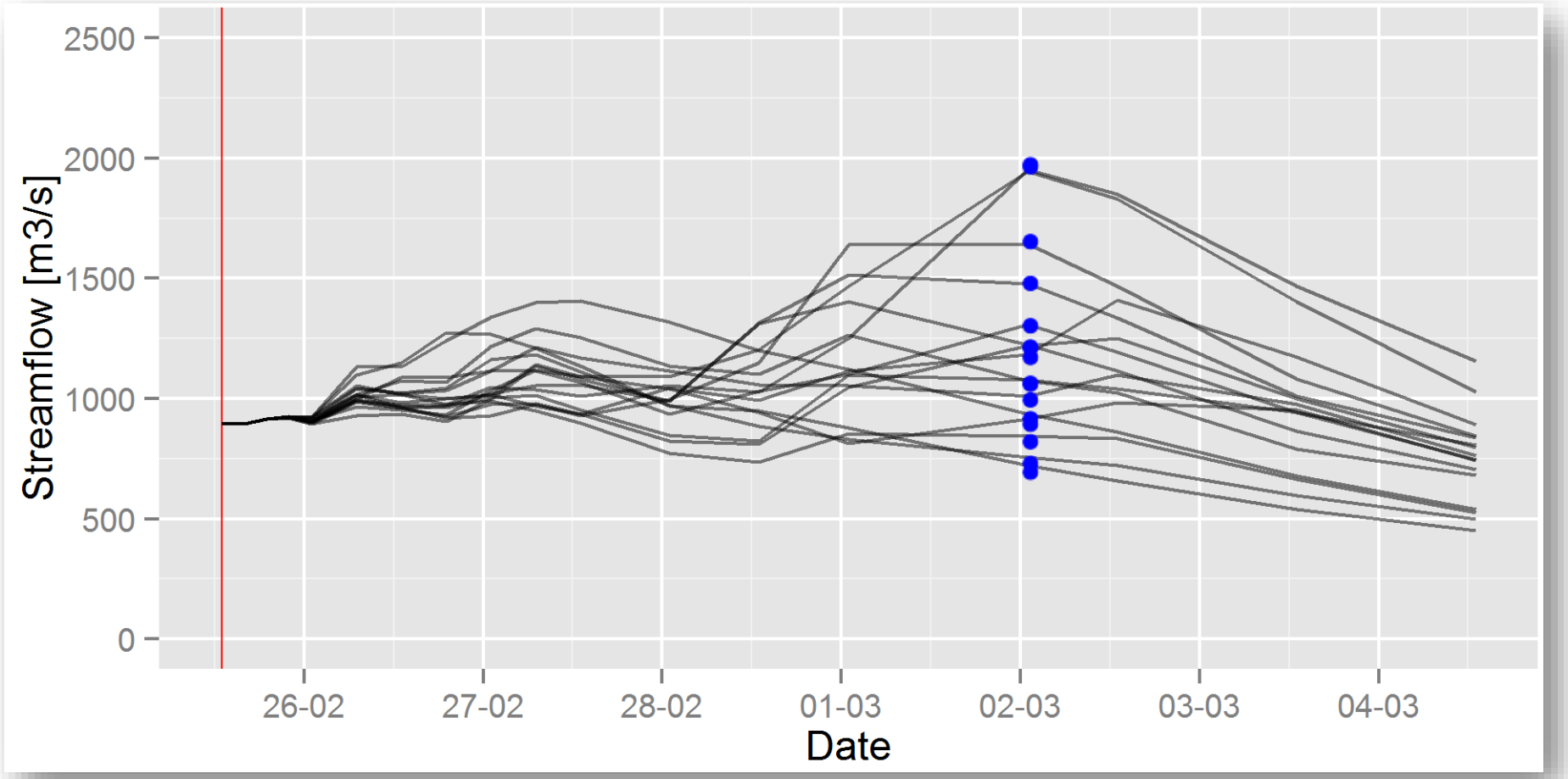
The ‘solution’…



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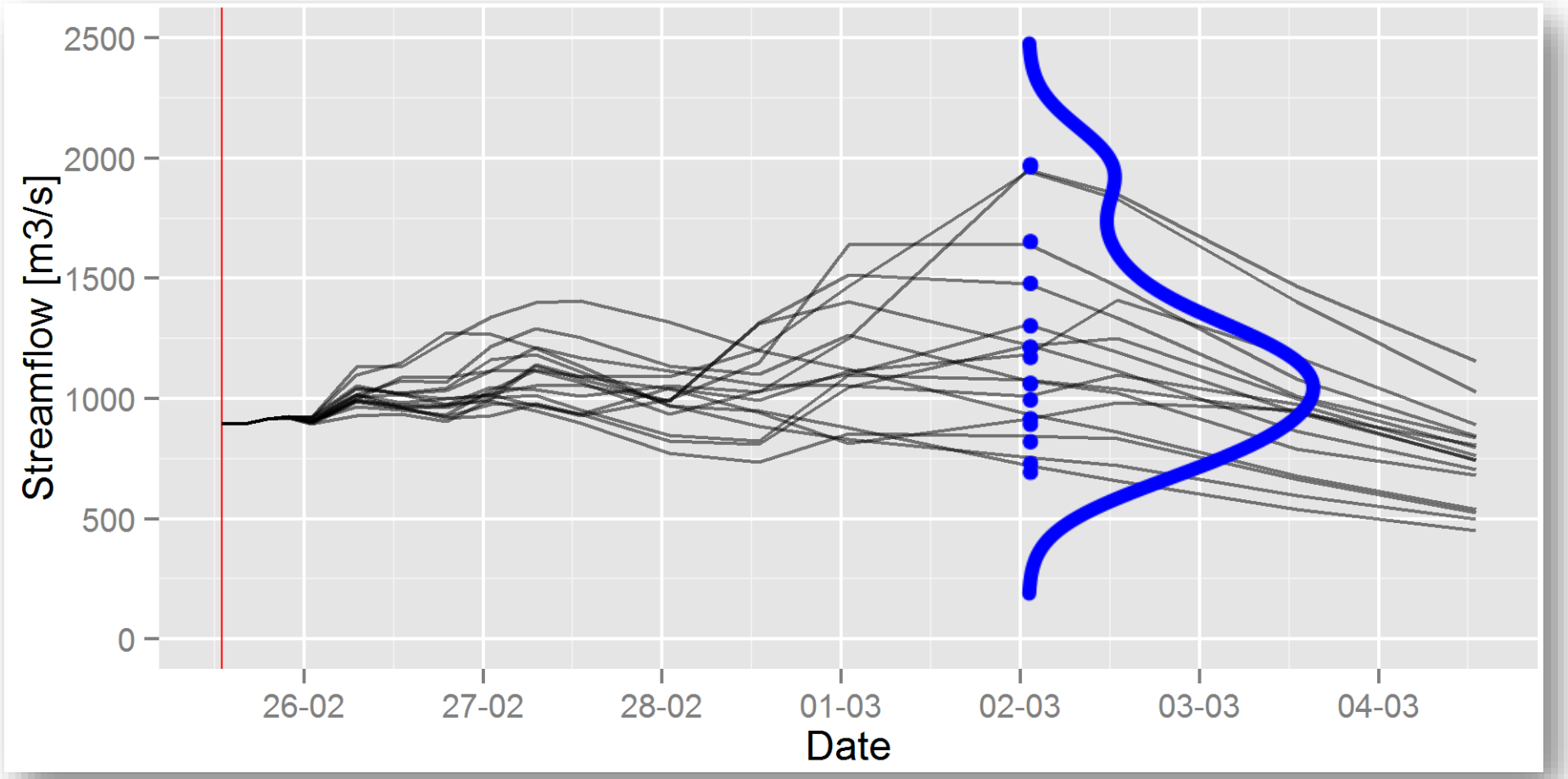
2500
2000
1500
1000
500
0
Streamflow [m3/s]
26-02
27-02
28-02
01-03
02-03
03-03
04-03
Date

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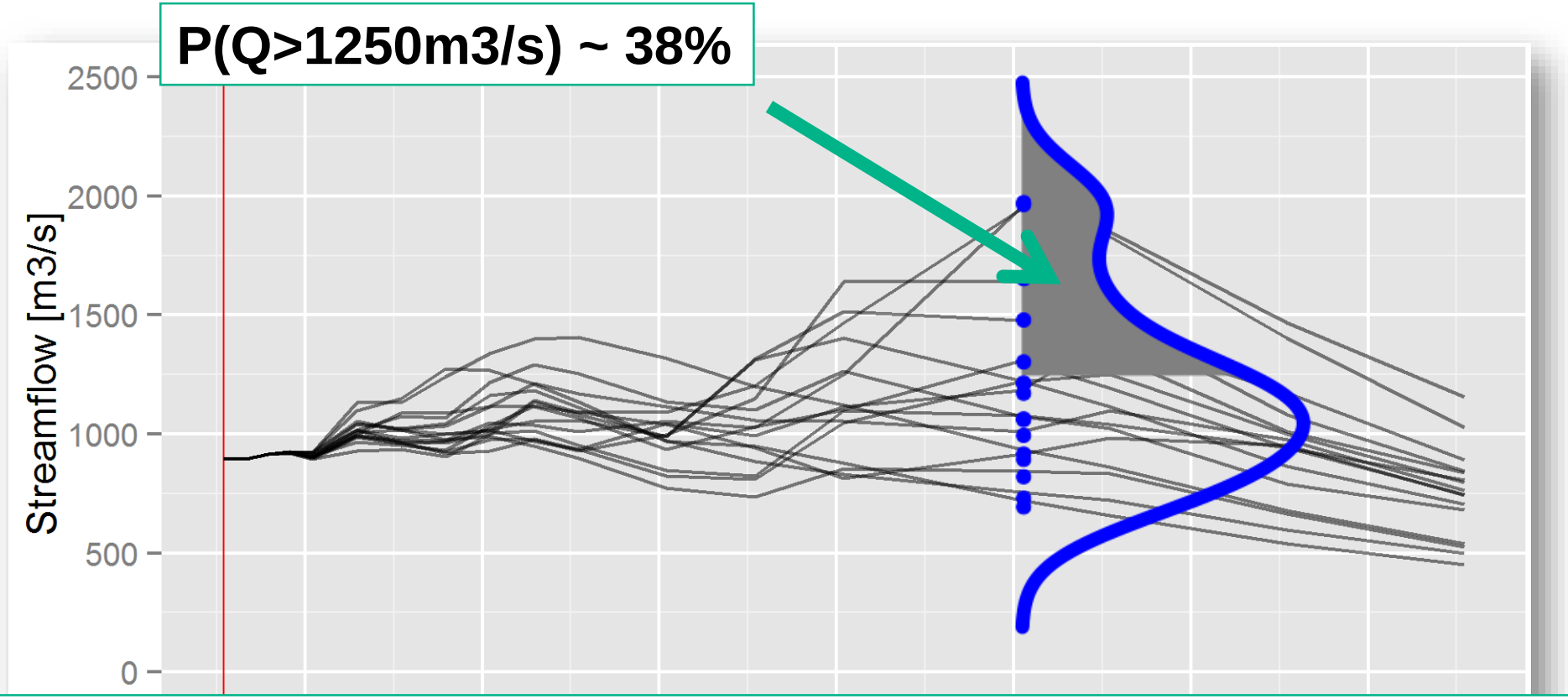


The ensemble plume does not immediately give the answer to our question
Complex cognitive reasoning required → high potential for error

https://dx.doi.org/10.1518/155534308X284354

The Effect of Uncertainty Visualizations on Decision Making in Weather Forecasting

Limor Nadav-Greenberg
Susan L. Joslyn
University of Washington, Seattle
Meng U. Taing
University of South Florida, Tampa

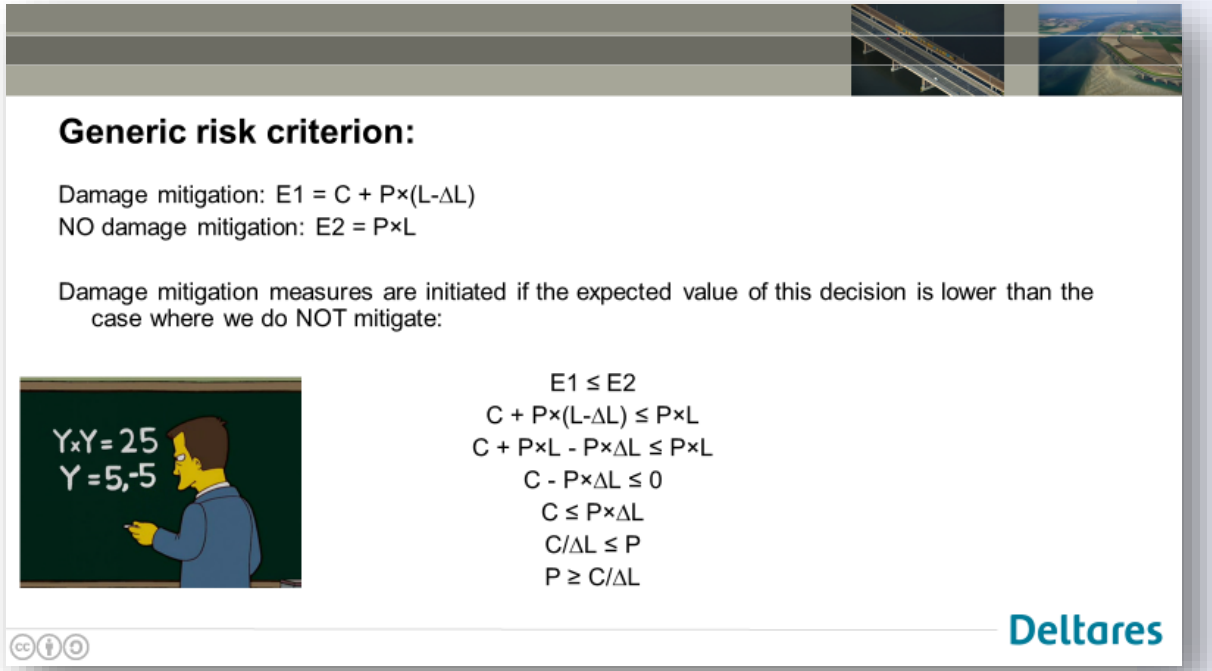
Abstract: People's reasoning with uncertainty information is often flawed. Visual representations can help, but little is known about what is the best way to present such information. Two studies investigated the effect of visualizations on the understanding and use of wind speed forecast uncertainty. Participants varied in expertise from novices in weather forecasting (Experiment 1) to professional forecasters (Experiment 2). The authors investigated three visualizations: (a) a chart showing the amount of uncertainty, (b) a chart showing the worst-case scenario, and (c) a box plot of likely wind speeds. Participants were asked to determine the relative uncertainty in the forecast, predict wind speed, and decide whether to post a high-wind warning advisory. The

“35% probability of flooding”… decision making in uncertainty

Lay down decision rules in procedures

1. ≥ three consecutive EPS runs indicate P_{exc}(“high”) ≥ 30%
   AND
2. ≥ one deterministic forecasts ≥ “high”
   AND
3. EPS, deterministic forecasts are consistent
   AND
4. Yesterday’s, today’s forecast indicate similar timing of peak (± 1 day)

Determine decision rule based on *cost - loss*



The *Decision Making in Uncertainty Lab*

The *Decision Making in Uncertainty Lab*

- Deltares and Leiden University, dept of Cognitive Psychology (Dr Fenna Poletiek)
- Scope:
  - Forecast informed decision making
  - Subjective forecasting
  - Management of uncertainties
- Gathering knowledge and expertise: *desk research*, experiments, field research
- Apply and disseminate expertise: reports, publications, training, serious games

Decision Making in Uncertainty Lab: current state

- Funded by Deltares strategic R&D funds
- We are looking for case studies to apply expertise
- Examples:
  - Noise audits and reduction of noise
  - Visualisation of probabilistic forecasts
  - Improving the quality of subjective forecasts
  - Help developing decision rules
  - ...
- Question to you: do you see any useful acivities of our Lab?

Flooding

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Helena Horton
Environment reporter

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The end-of-winter floods would be a result of a weather phenomenon called La Niña - a powerful pattern influenced by cooler temperatures in the Pacific. This is what caused flooding in February, when storms damaged hundreds of homes.

Probabilistic interpreation of the word MAY

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