Role-play games to advance probabilistic forecasting in hydrology

Maria-Helena Ramos (1)

S. J. van Andel (2), F. Pappenberger (3), L. Crochemore (4),
A. Wood (5), M. Zappa (6), K. Liechti (6), L. Arnal (3,7),
H. L. Cloke (7), E. Stephens (7), F. Wetterhall (3), M. Werner (2,8),
M. Cranston (9)

(1) Irstea, Antony, France (maria-helena.ramos@irstea.fr),
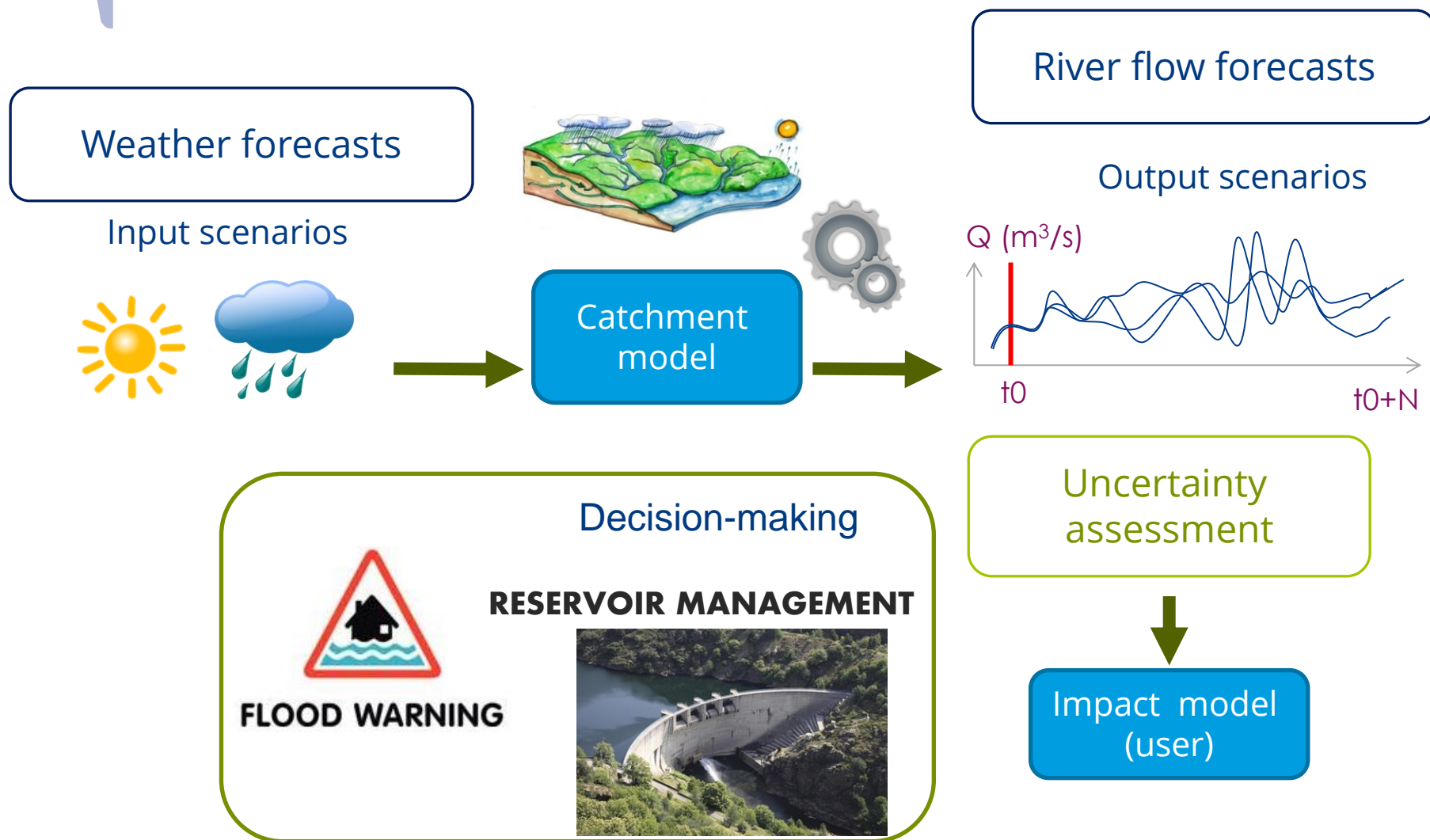(2) IHE Delft Institute for Water Education, the Netherlands, (3) ECMWF, Reading, UK,
(4) SMHI, Norrköping, Sweden, (5) NCAR, Boulder, USA,
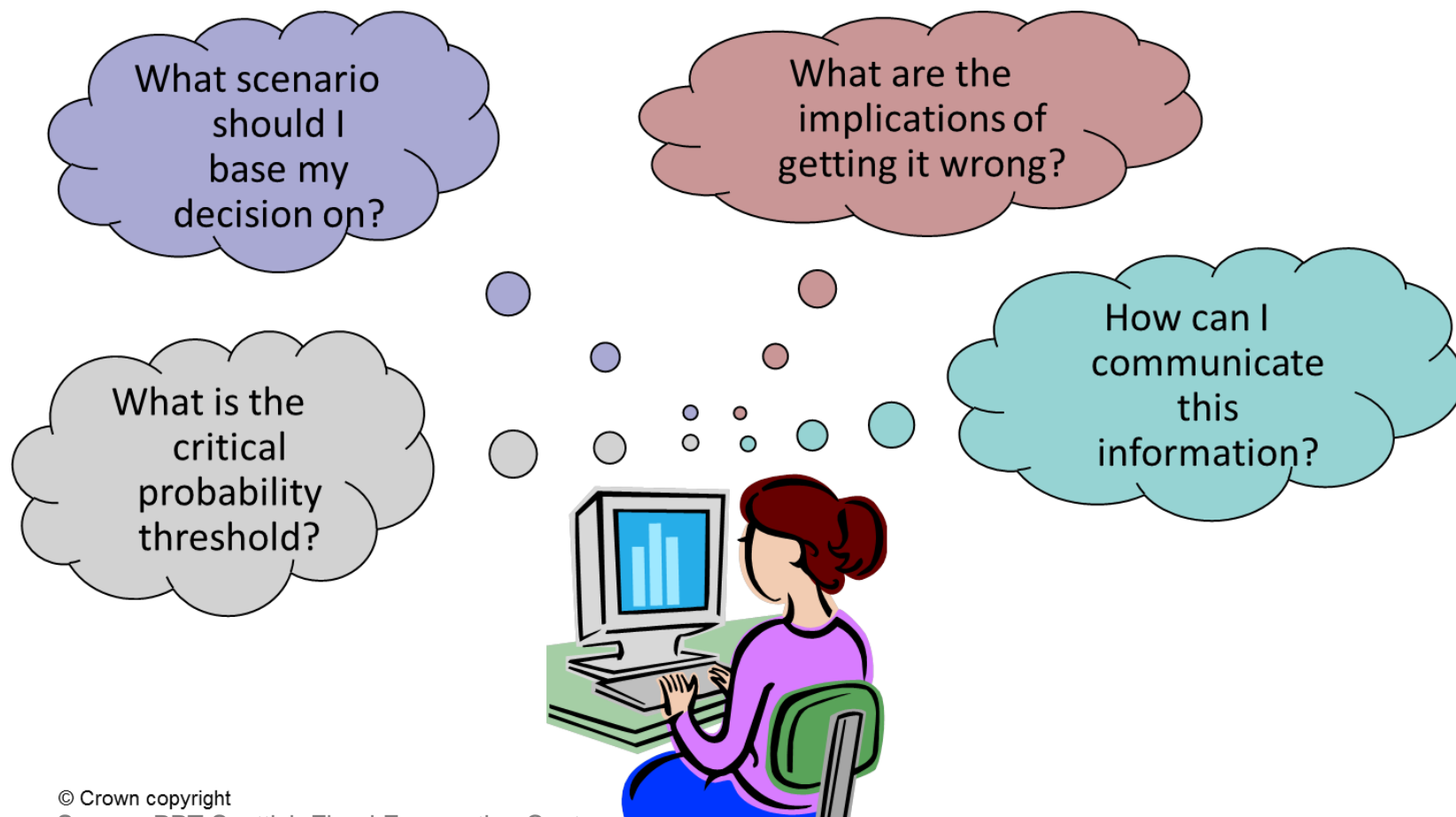(6) WSL, Birmendorf, Switzerland, (7) University of Reading, UK,
(8) Deltares, Delft, the Netherlands, (9) RAB Consultants Ltd, Stirling, Scotland

EGU 2018, Vienna, 11 Apr 2018

Context of game applications

River flow forecasts

Weather forecasts

Output scenarios

Input scenarios

Q (m^3/s)

Catchment model

$t0$ $t0+N$

Uncertainty assessment

Decision-making

RESERVOIR MANAGEMENT

FLOOD WARNING

Impact model (user)

Use and communication of uncertain, probabilistic forecasts

© Crown copyright
Source: PPT Scottish Flood Forecasting Centre
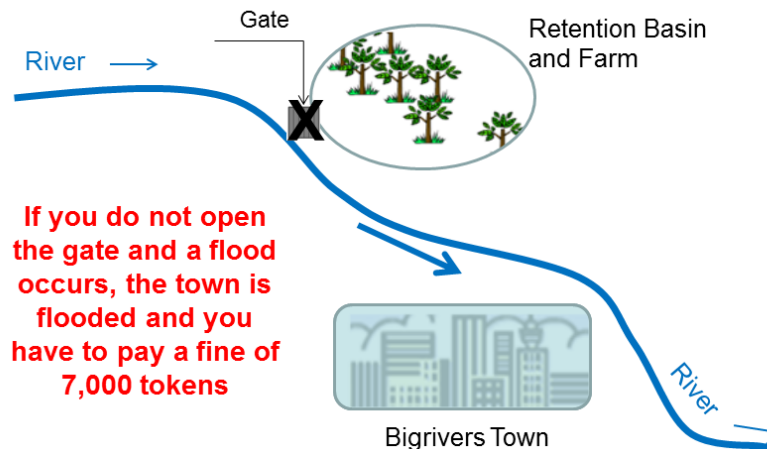
Our motivation

- Busting **forecasting myths**:
  - ➤ "*Probabilistic forecasts are not useful*"
  - ➤ "*We cannot make decisions with forecast scenarios*"

- Reflecting about the "**real world out there**": investigating wrong or missing perceptions about forecast users and the way forecasts are used in practice

- **Curiosity**
- To have **fun**

Examples: try it yourself!

Game:

- Do probabilistic forecasts lead to better decisions?
- Ramos *et al.*, 2013

Your company has received 30,000 tokens for a flood protection contract. You have to manage a gate which is the inlet of a retention basin designed to protect the town of Bigrivers.
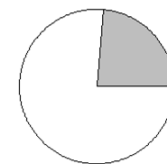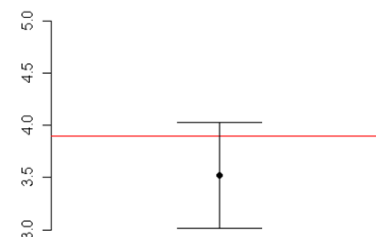
Gate

River →

Retention Basin and Farm

1. Set the scene

If you do not open the gate and a flood occurs, the town is flooded and you have to pay a fine of 7,000 tokens

River

Bigrivers Town

2. Provide information and ask for a decision

Expected output: 3.52 metres +/- 0.51   Probability of flooding: 23.59 %

Do you want to open the gate to the retention basin?

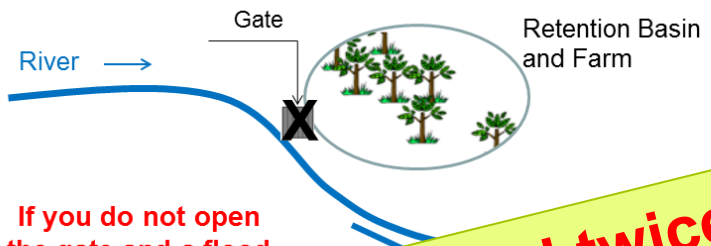Yes   No

Examples: try it yourself!

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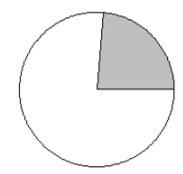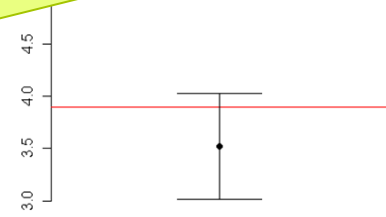
Gate

River →

Retention Basin and Farm

X

If you do not open the gate and a flood occurs, the town is flooded

...cene

...metres +/- 0.51   Probability of flooding: 23.59 %

4.5
4.0
3.5
3.0

information and ask for a decision

Do you want to open the gate to the retention basin?

| Yes | No |

A game to be played twice: with and without uncertain information.

How it affects your decisions!

Examples: try it yourself!

Game:

- Peak box Game
- Zappa *et al.*, 2013

How big will the observed peak discharge be?
At what time will the peak discharge occur?

Write your co-ordinates, e.g.: G-26

You need a pencil!
-> Check one box!

Verzasca, init: 25.04.2013 01:00

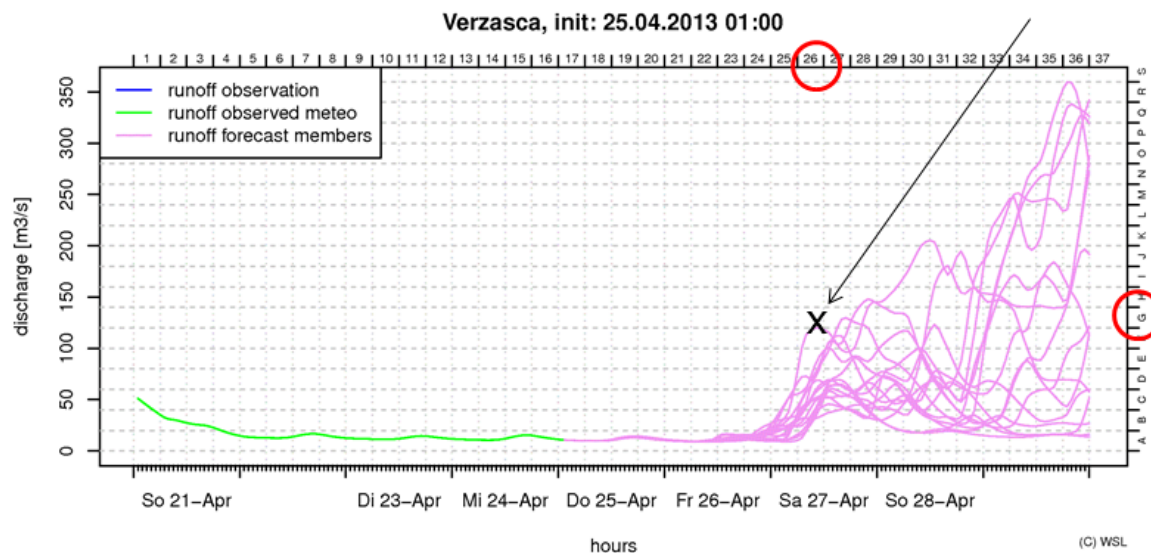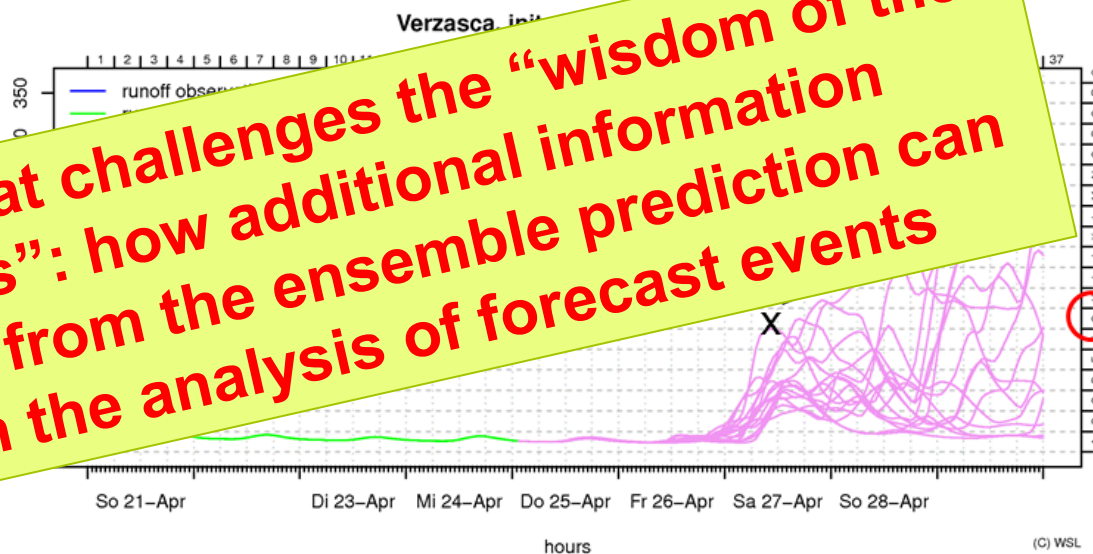# Examples: try it yourself!

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Verzasca, init

350   — runoff observ

So 21–Apr   Di 23–Apr   Mi 24–Apr   Do 25–Apr   Fr 26–Apr   Sa 27–Apr   So 28–Apr

hours

(C) WSL

A game that challenges the "wisdom of the crowds": how additional information extracted from the ensemble prediction can help in the analysis of forecast events
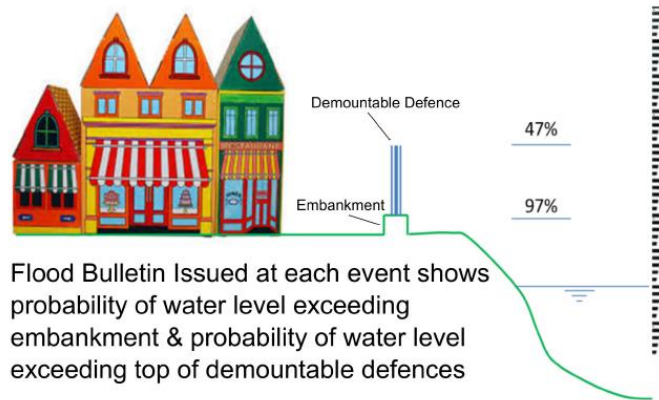
Examples: try it yourself!

Game:

- The Shopkeepers Dilemma
- Werner *et al.*, 2016

Flood Bulletin Issued at each event shows probability of water level exceeding embankment & probability of water level exceeding top of demountable defences

Demountable Defence — 47%
Embankment — 97%

Make Your Decision:

- **Do Nothing**
- **Raise Flood Defences**
- **Move Inventory**

If you are the owner of…
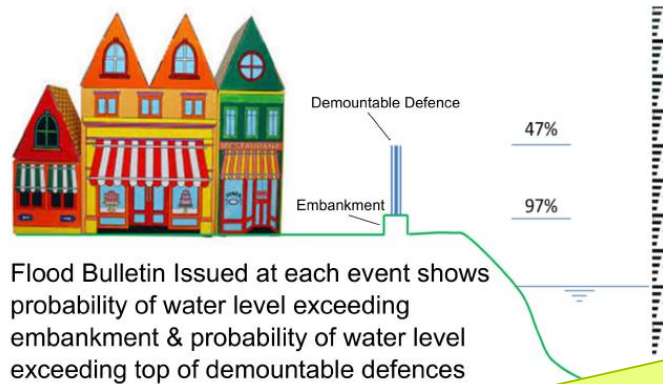
Shop 1: Ferraris

Shop 2: Groceries

Shop 3: Gravestones

	Ferraris	Groceries	Gravestones
Initial Savings	€ 500,000	€ 100,000	€ 25,000
(-) Do Nothing	€ 0	€ 0	€ 0
(D) Raise Defences	€ 10,000	€ 10,000	€ 5,000
(I) Move inventory	€ 25,000	€ 5,000	€ 4,000
(L) Losses if flooded	€ 100,000	€ 20,000	€ 4,000
(P) Profits when open for business	€ 25,000	€ 10,000	€ 5,000

Examples: try it yourself!

Game:

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If you

Make Your Decision:

- **Do Nothing**
- **Raise Floo**

Gravestones

Free Inscriptions

Fully fitted from only £399

CLICK HERE

	Ferraris	Groceries	Gravestones
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A game that shows that users with different cost/loss ratios react differently to the forecast information they receive

Examples: try it yourself!

Game:

- Pathways to designing and running a flood forecasting system

- Arnal *et al.*, 2017

- H2020 IMPREX project
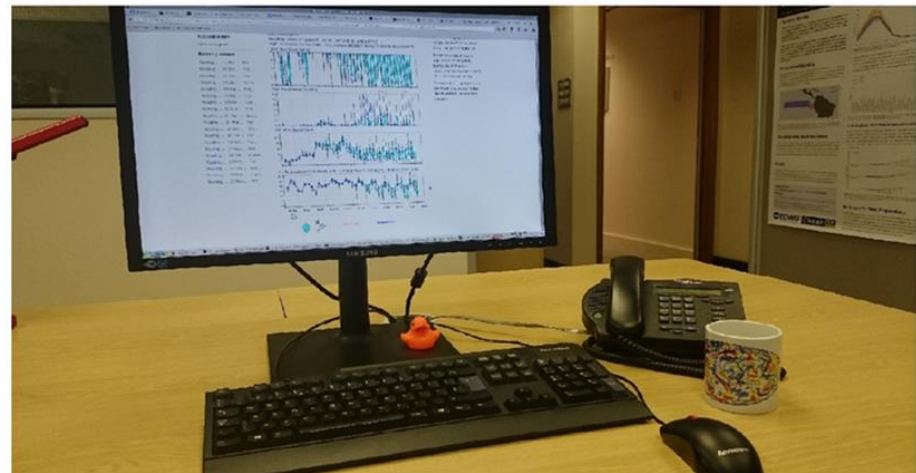
Day 1

You are in your office.
You can see a computer.
1. Would you like to see the latest forecast on it?
2. Or would you rather work on the paper you're about to submit?
Or
3. You can go to the forecasters' room
4. Or to the flood incident room and talk to the people working there.

Click on the option of your choice.

Examples: try it yourself!

Game:

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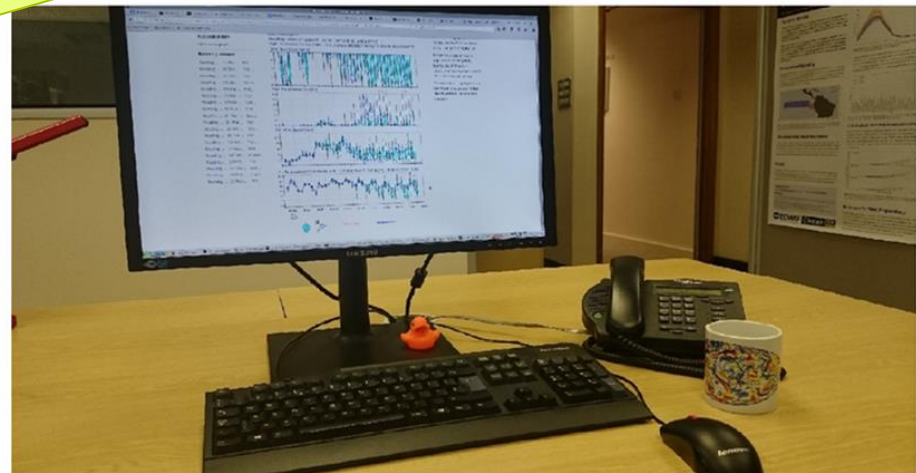1. Would you like to see the latest f
2. Or would you rather w
Or
3. Yo

...e people working there.

...choice.

An adventure game where you can gain popularity but lose money if you don't take action at the right moment!

Step 1: Design

S
T
E
P
S

- Clear definition of what you want to know/investigate
- Setup:
  - ✓ the player's goals (as decision-maker)
  - ✓ actions available to the decision-maker
  - ✓ relevant information that should be available (ex., forecasts, management constraints, a decision rule based on a flood threshold level)
  - ✓ consequences following each possible action-event pair (payoff function)
  - ✓ outcomes (how they will impact the decision-maker and provide an answer to what you want to know)

Step 2: Build

- PPTs/PDF: step by step instructions (test it extensively!)

- Worksheets to be distributed and collected at the end, or online game (with access to results)

Worksheet:

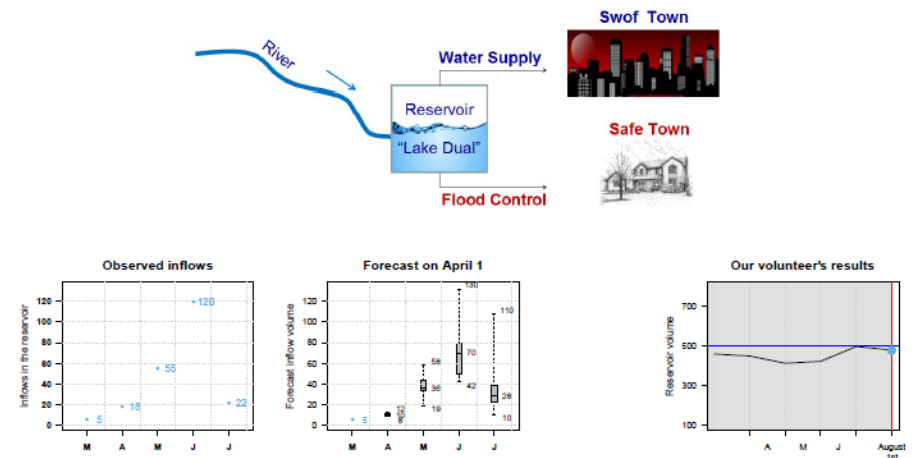Online game:

Step 2: Build

- PPTs/PDF: step by step instructions (test it extensively!)

- Worksheets to be distributed and collected at the end, or online game (with access to results)

- Game over: think about conclusions, take-home messages

Water management game (Crochemore *et al.*, 2015)

Previous decisions: B B C C

GAME OVER

August 1st has arrived.
If you did not overtop the reservoir, you still have a job and you are hired for the next season!

How did you like this experience as a decision-maker?

Step 3: Play

- Make sure people are ready to **play a role**!
- Raising hands, volunteers, individual players/groups
- Save their answers (game sheets)
- Award the winner(s)

EGU Ensemble Forecasting
session in 2012

IMPREX project
meeting in 2017

HEPEX Workshop
in 2016

Step 4: Write about the results

- Don't think your results are useless (just because things didn't happen exactly as you expected!)

PUBLISHED

- Avoid falling into over-interpretations: stick to what your observations can tell you, cross check with your colleagues

- Avoid individual/personal responses: go for statistics

- Link your findings to other people's findings: contribute to build a body of role-play game experiences in your field

- Make your game (and results) public and disseminate it!

Last remarks

- Excellent way to **introduce complex concepts** or test new products during teaching, training or workshops

- Opportunities to engage **early career scientists** (science ⇔ practice)

- Great for **demonstrating different concepts / play with real world scenarios / perceptions**

- Our games:

  - not designed to robustly test a hypothesis about **decision-making behaviour** (need of replication in a particularly controlled setting)

  - mostly target modellers / forecasters. Another **target group** could have been the general public (another design and implementation approach needed)

All games are available for free!

www.hepex.org **(international volunteer effort since 2004)**

HEPEX

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HEPEX

A Global Community In Hydrological Ensemble Prediction

HEPEX GAMES

Below you'll find links to download and/or play several games created by H[...]
to both science and decision-making aspects of hydrological ensemble predi[...]

3. Games and training on the use of probabilistic predictions

Flood control game

- Download: English (original version), French, Chinese, Italian, Swedish, Finnish
- Reference: Ramos et al., 2012

Water management game

- Download: English (original version), German
- Reference: Crochemore et al., 2015

Peak Box game

- Download: Peak Box Game
- Reference: Zappa et al., 2013
- HEPEX blog post

Pay for a forecast game

- Download: Pay for a forecast game
- Reference: Arnal et al., 2015

If you have a forecasting game to share, send it to us!

Thank you!