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The Future of Hydrological Forecasting – a scenario analysis

Nadine Slootjes

The Future of Hydrological Forecasting

Brief introduction: Nadine Slootjes

- Expertise in Flood Risk Management and hydraulics
- Department manager Deltares Operational Water Management
- Hydraulic expert operational team Maeslant barrier



Outline



Motivation



Methodology



Scenarios



Vision



Motivation

- Deltares and the Delft-FEWS community for real time hydrological forecasting currently use state-of-the-art expertise and tools
- We'd like that statement to be true in 2025
- The world is changing, hence we need to anticipate those changes
- If we want to adequately respond, we need to anticipate those changes:
 1. Exploration of the future
 2. Development of strategies



A satellite image of Earth showing South America and the surrounding Atlantic Ocean. A large hurricane is visible in the upper left quadrant. The text "The world is changing" is overlaid in the top left.

The world is changing

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Our “macro environment” always changes



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Our “macro environment” always changes



Our “macro environment” always changes



Our “macro environment” always changes



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An aerial photograph of a city, likely New Orleans, completely inundated with floodwater. The water is a murky brown color, and numerous buildings, trees, and structures are partially submerged. The city's layout is visible through the water, with various sized buildings and green spaces. In the background, more city structures and a bridge can be seen. The overall scene depicts a significant natural disaster.

Our “macro environment” always changes

Our “macro environment” always changes



Our “macro environment” always changes

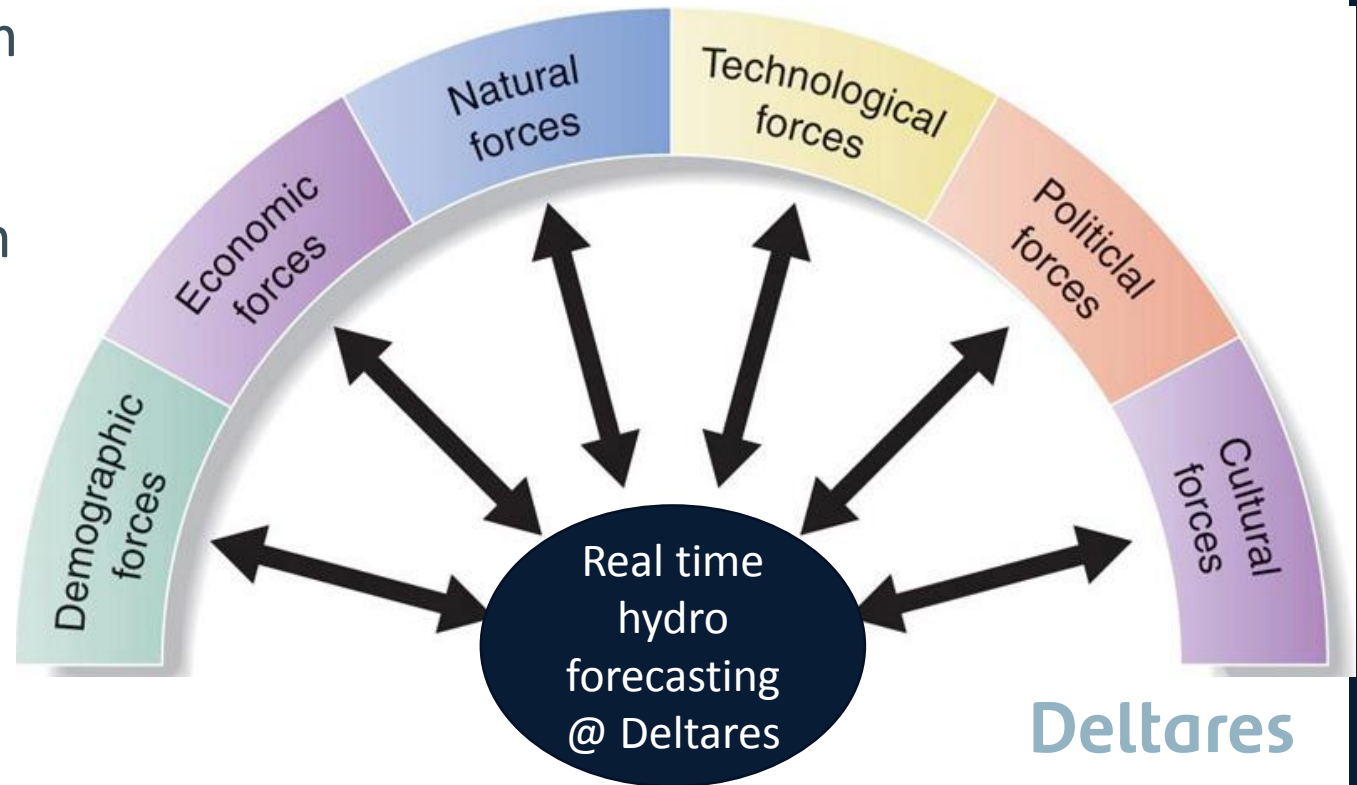


Our “macro environment” always changes



The world is changing

- Our macro-environment is changing.
 - increasing populations in flood prone areas;
 - composition of EU; US foreign policy choices;
 - shift of responsibilities from gov'm
 - ...
- Some of these changes may result in deterioration or loss of the current position in forecasting



THE SCENARIO DEVELOPMENT PROCESS

Define Focal Issue, Question, or Decision and Relevant Timeframe
Review Past Events & Alternative Interpretations

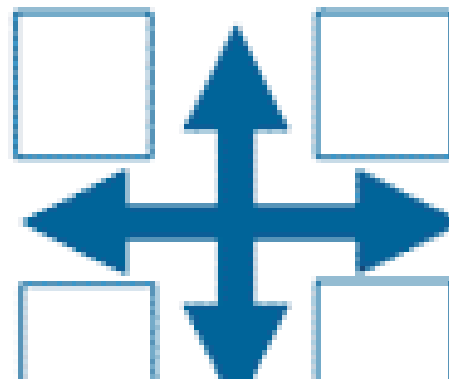
**Identify
Driving
Forces**



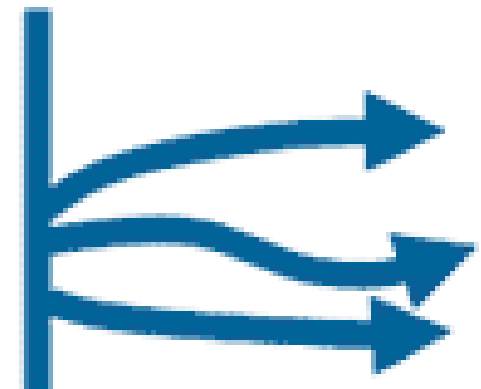
**Identify
Critical
Uncertainties**



**Develop
Plausible
Scenarios**



**Discuss
Implications
& Paths**



Exploration of the future

Typical questions we'd like to see answered:

- Will governments still be forecasting for the general public?
 - Will governments still be forecasting for the general public?
 - Will forecasting still be based on process models such as rainfall-to-runoff, streamflow propagation, storm surge estimation, etc?
 - Who will be the suppliers of forecasting systems?
 - ...
- We cannot know the answers to these questions with certainty.
- We *can* develop multiple, plausible scenarios



Development of scenarios

- Brainstorm session
- Five authors, five scenarios, five days of full-time writing
- Two “key variables” were chosen:
 - governmental focus
 - technology focus



Development of scenarios

- Five (out of nine possible) scenarios were developed
 - Storyline:
 - The path to 2025
 - “A day in the life of...”
 - What are the effects in terms of knowledge development, collaboration and market
 - Completion in terms of additional macro-environmental factors



Scenario analysis report



<https://www.deltares.nl/en/blog/the-future-of-realtime-hydrological-forecasting/>

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Factors and viewpoints

Government Focus

Traditional
Government

Regulatory
Government

Glocal

Opportunistic

User Oriented

Protectionist

Technology Focus

Scenario system

Government Focus

Traditional
Government

Conditional for the development of a
diversity of commercial activities

Caring
Government

Regulatory
Government

Conditional for the
development of a diversity of
commercial activities

Regulatory
Facilitator

The market is directed by
standards and certified
partners to guarantee quality

The Moat

Glocal

International, technocratic
interest and geographic networks
for new opportunities

Google
Forecasts

Target-group-specific, local
interests and a diversity of
data lead to conflicts between
government and companies

Start-up
Society

Opportunistic

User Oriented

Protectionist

Technology Focus

The path to 2025

Caring
Government

Collaboration between Rijkswaterstaat and the Water Boards has changed from information exchange to joint information provision. As a result the collaboration has been intensified in a relatively short time. The urge for **one joint organization** to benefit the users has led to the creation of one joint organization for water reporting: a single contact point for clear, unequivocal information.

With a view to create greater efficiency and to avoid the duplication of work, political bodies pressed for a merger between Rijkswaterstaat and the Water Boards. However, a study revealed that there was almost no duplication (much of the same work was done but in different regions, involving different people) and that reorganization would cost more than it would yield. Increasing efficiency was, however, possible by combined water reporting, and it was found that extension of services with a joint approach would have added value for the users. To the satisfaction of those users and the political bodies, this change was implemented in a relatively short time.

The zeitgeist in which products were developed and offered top-down has almost completely changed in the last decade. Civic participation in design and implementation is now part and parcel of the normal functioning of the market. By bringing the right expertise and openness into the contacts with citizens (and other stakeholders in the provision of water information), better **tailored products** can be offered in a more timely manner. A party that provides the information is seen as increasingly valuable and reliable, an image which is also sustained in politics.

Thanks to the economic optimism of the 2020s, people no longer question the need for investments in public services, and there is a renewed sense of **People no longer question investments in public services**.

Scenario: Caring government



- Forecasting is organised in one central government organisation
- Government is responsible for the forecasts – also producing the forecasts
- Focus on end-user needs – additional products (farmers, navigation, ...)
- More or less “business as usual”

Scenario system

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The path to 2025

Government policy between 2017 and 2025 emphatically states that the number of civil servants should be reduced. Vigorous implementation

...government has no longer executive tasks...

...new small business in the field of hydro forecasting...

research. This is new in research. Fundamental research is left to universities and applied research to commercial organizations.

Another trigger for change was the elimination of the 'safety divide', which had hitherto existed. No agreement had ever been reached on

...provision of safety in the field of hydrology and meteorology could be left to other parties than government...

concerned would keep to the specifications drawn up and monitored by KNMI and Rijkswaterstaat.

Although there is concern about the dependency on commercial parties (a

...many opportunities for innovation

wants to encourage the formation of small businesses. Thanks to this new policy, many such companies have emerged.

The disentanglement process in the field of research took time. Technological developments, such as improving and developing models and researching

...technological developments were transferred to other organisations...

research and operational tasks. This process was finally completed in 2023. In 2024, the production of water and weather forecasts (including alerts) was transferred to the commercial party that came with the best offer.

The Royal Netherlands
Meteorological Institute (KNMI)
and Rijkswaterstaat outsource not
only tasks such as measuring and
predicting but also research.

Characteristics

- Cost efficient government
- Government no longer has executive tasks, but responsible; hydrological forecasts are made by commercial companies
- Research at universities, applied research at private sector
- Market impuls forecasting as a service
- Strict requirements (data, production process) (Moat)
- Data property of the producer, certification (Moat)

Scenario system

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Conditional for the development of a diversity of commercial activities

Caring Government

Conditional for the development of a diversity of commercial activities

Regulatory Facilitator

The market is directed by standards and certified partners to guarantee quality

The Moat

Regulatory Government

International, technocratic interest and geographic networks for new opportunities

Google Forecasts

Target-group-specific, local interests and a diversity of data lead to conflicts between government and companies

Start-up Society

Glocal

Technology Focus

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The path to 2025

2017 was a year of change. After the Dutch elections, a nationalist

... citizens have turned their backs on the government...

had turned their backs on the government. As a result, various social initiatives emerged, taking advantage of the revolution in information and communication technology, such as health, energy and security

...various social initiatives; regaining control over their own lives...

Over the years, that technological progress continued. More and more data became available to more and more people, and also became more easy to use thanks to new devices. Surprisingly enough, the government no longer functions as a major data supplier and other parties are also taking over its role of user and translator of data. Multinationals in particular but also a multitude of small businesses are taking advantage of the large amount of data that is made available. The nature of the required information has also changes. For example, hydrologists noticed

...more and more data become available, opportunity for new services...

Confidence in government remains low, mainly due to the inability to solve major problems in a highly polarized society. New social initiatives are therefore increasingly focused on involving all groups in society. Sustainable initiatives also remain popular, and are increasingly needed because of developments such as increasing population growth, economic growth and climate change.



The decrease in the amount of rules
and the favourable tax environment
created a breeding ground for small
businesses and new initiatives from
around the world

The path to 2025

By 2021, the government decided to decrease public services. In recent years, it was found that there are enough suitable parties to take over

...weather services are shut down, knowledge institutes no longer funded...

this decision was taken, more and more services were hived off with the idea that "essential services will be taken care of by the market." The Royal Netherlands Meteorological Institute (KNMI) was closed down, the ministries became at least 50% smaller, and the funding of a large number of knowledge parties was stopped. Tens of thousands of employees were made redundant.

The decrease in the amount of rules and the favourable tax environment created a breeding ground for small businesses and new initiatives from around the world. One example is the multitude of courses that have

...successful capabilities: translating technology into practice, communication to the general public ...

Previously flourishing professions, such as those of hydrologists and civil engineers, appear to have become less attractive. Part of their work is being taken over by clever staff who can process large amounts of data and people who can translate the results of water system analyses for the general public.

Start-up
Society

Communication tools such as flashu, infographics, augmented reality apps

...IMPACT is the magic word...

long term. The international networks in which the start-ups operate also prove to be a breeding ground for new innovations. As far as hydrological forecasting systems are concerned, the players that can make the translation to the actual impact of forecasts are the most successful. They are able to answer all kinds of queries from customers (including more and more civil cooperatives) satisfactorily.

Scenario: The start-up society

- The start-up society is a society formed by citizens, start-ups and multinationals without strong government.
- Innovation flourishes and technological development is faster than ever, mainly driven by the growing amount of available data.
- Strong focus on end user: forecast use. Services in which information is translated into impact, i.e. impact on themselves and impact on society.

→ Attention to *impact forecasting*, and *effective use*

Scenario system

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The path to 2025

In social policy the years from 2015 to early 2017 were a period in which global thinking, which had rapidly evolved in the previous years, was called to a halt. With emerging protectionism in the United States and Europe, it was as if someone had suddenly stepped on the brake.

... China and Russia evolved into openly sharing data...

behind. But the West could not hold the brake down for very long. Society came to the conclusion that protectionism was counterproductive. The route back to the open data and open source world was quickly found. The new worldwide sense of openness was at its peak in the period 2020-2025. The Chinese and the Russians could also not go back. It seemed a masterly strategy of the West, but it had not been planned like that.

These political developments undermined the public perception and any remaining image of the integrity of politicians even more. The lack of trust in the government never so low

government as the defender of their interests had been denied. Government was seen as the extension of the failed political order.

Technology had not stood still in the meantime. Big Data, the rising concept in 2015, had become commonplace in 2025. Concerns about privacy and misuse had been replaced by visions of the unprecedented opportunities all

...technology push...
own interests. Society had surrendered to the rapidly globalizing and openly accessible data and information. Galloping at full speed on the public digital racecourse, but with the reins firmly in hand.

Therefore, large investments were made in technology. Citizens clearly realized that by combining forces at the local, national and international levels, they would locally be able to make full use of what was globally

...global hydrological models have been brought down to a very detailed scale...

population lived in cities, and the need for information and forecasts specifically aimed at the city and its citizens was the most urgent. The increasing occurrence of weather extremes, such as storms, flooding and drought, which climate scientists had forecast, increased people's awareness of climate change.

...High-resolution global hydrological forecasts had become a reality, offered by companies such as Google...

measurable at a level of detail relevant to society – everywhere in the world. Global hydrological models had quickly been brought down to a scale at which hydrological information about one's house or the ditch

...the weather service stopped making hydrological forecasts mid 2022. The distance between the global scale of Google Forecasting and the reliability and relevance at the local scale are very short in 2025....

Google
Forecasts

Scenario: Google Forecasts

- Globalization is back – welcome China and Russia!
- (Big) Data everywhere, no protection
- Global hydrological predictions based on high-resolution models, improved by the research community
- No predictions from government agencies anymore
- Glocal: Innovative businesses and citizen initiatives will combine global predictions providing multitude of services aiming at satisfying local information needs



Strategy development

- The future will look like a combination of aspects of the different scenarios
- Based upon these scenario, we decided to focus on:
 - Further development of global models
 - Start with the development of (global) forecasting services; Global forecasting data service operational end 2019.
 - Focus on impact forecasting
 - Webviewer development



What's next

- Development of a vision for Delft-FEWS 2025
- In close relation with the Community strategy board and users
- User Days US, Australia, Netherlands, German speaking countries, international User Days
- Kick off today → Break out session in the afternoon

Thank you for your attention

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www.deltares.nl



Hydrological Forecasting

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A photograph of a group of people, likely students, holding and looking at their smartphones. The image is slightly blurred, focusing on the hands and phones. A blue rectangular overlay is positioned in the lower-left corner, containing white text.

Get out your phone!

and browse to [Kahoot.it](https://kahoot.it)

This afternoon's programme

| Time | What |
|---------------|--|
| 15:30 – 15.40 | Introduction: <ul style="list-style-type: none">• To this session/program• Short introduction round (name and organization) |
| 15.40 – 15.55 | Kahoot! |
| 15.55 – 16.20 | Brainstorm round 1 - identification of current trends |
| 16.20 – 16.35 | Brainstorm round 2 - identification of trends into near future (2025) |
| 16.35 – 17.00 | Conclusions |

Brainstorm: rules of the game

- Try and make groups as diverse as possible: level of experience, expertise, etc
- Chatham House Rules
- We have 75 minutes available
- We'll re-convene two times to share our findings

*When a meeting, or part thereof, is held under the **Chatham House Rule**, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.*

Brainstorm 1: identification of current trends

- Which trends/developments from the (recent) past have shaped the present day?
 - → “Strong signals”

Brainstorm 1: identification of current trends

SHARE YOUR FINDINGS

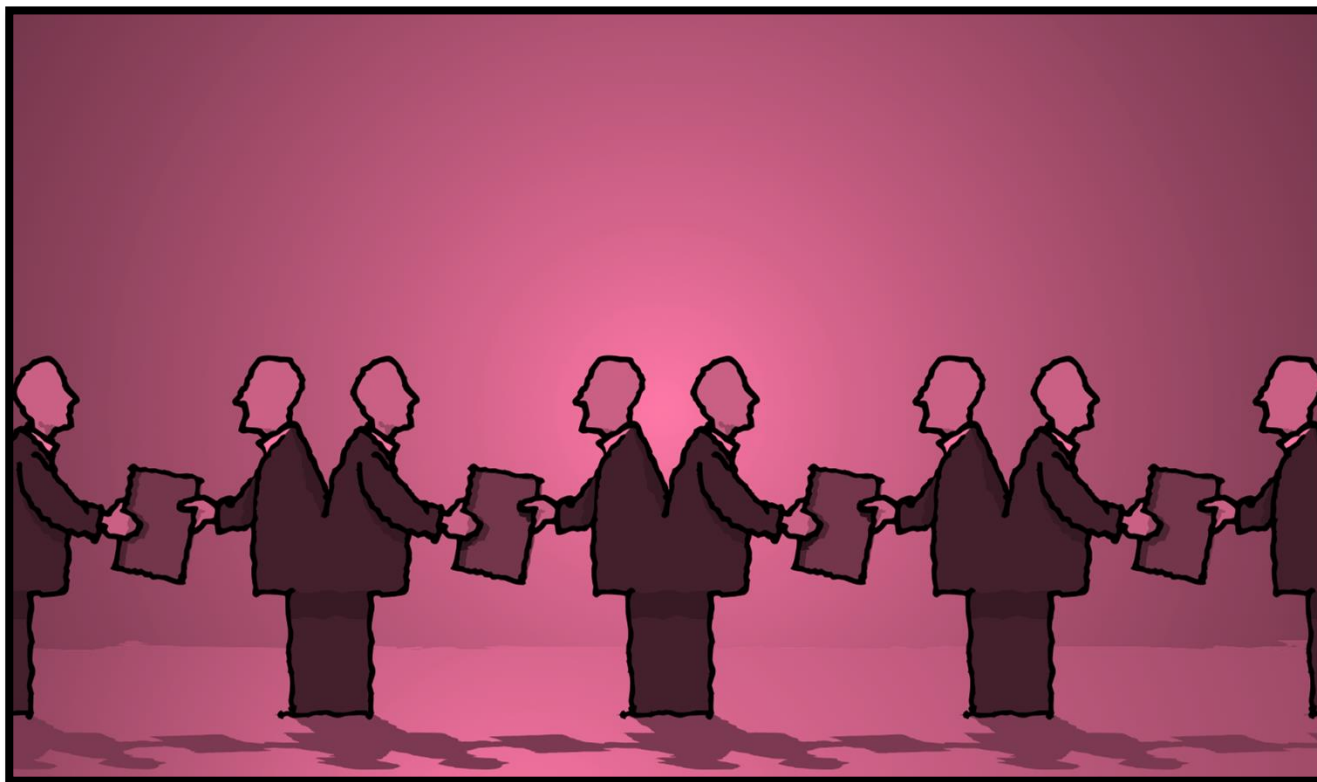


Brainstorm 2: identification of trends into near future (2025)

- Which current trends/developments do we expect to shape our world in 2025?
 - → “Weak signals”

Brainstorm 2: identification of trends into near future (2025)

SHARE YOUR FINDINGS



Conclusion

- What developments have we identified?
- What are most relevant developments in relation to Delft-FEWS 2025