



Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Market Consultation for project Forecast Assistant

Project: The market consultation is part of AI Impulse programme for Water Movement Models (AIWaM).

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1 Introduction

1.1 Identification

Rijkswaterstaat is exploring the possibility of initiating a Request for Proposal (RFP) for a Forecast Assistant, e.g. a tool and/or agent or a subset of tools and or agents which support the hydrological forecaster to get the right information efficiently and effectively. The outcome of this market consultation will, among other things, serve as input for this decision. In addition, through this market consultation Rijkswaterstaat expects to form a better picture of the assignment and to receive input from the market, whereby the approach as formulated by Rijkswaterstaat is submitted to the market for validation. Through this market consultation, Rijkswaterstaat aims to gain a better understanding of available market solutions, validate its current thinking and requirements, and assess the feasibility of potential approaches. The insights obtained will help shape the scope and objectives of a possible follow-up RFP and support informed decision-making on the most appropriate way forward.

Participation in the market consultation does not confer any right to be selected in a follow-up procedure. Any follow-up procedure will be open on equal terms to all suppliers. It is our goal to start this RFP within six months.

We therefore warmly invite interested organizations to respond and share their views, experience, and proposed solutions. Participating organizations will also have the opportunity, on a voluntary basis, to present their proposed Forecast Assistant during the DigiShape event on 19 November.

Rijkswaterstaat recognizes the time and effort required to participate in this consultation and greatly appreciates the contribution of market parties.

1.2 The AI Impulse Programme

To keep the Netherlands safe, liveable and accessible in the face of climate change, the AI Impulse Programme for Water Movement Models (AIWaM) aims to enable more agile, faster and better-informed water management. Through the development of machine learning models and high-quality datasets for the national water system, including rivers, lakes and coastal waters, Rijkswaterstaat seeks to respond proactively, adaptively and in a data-driven manner to the increasing unpredictability of weather and water conditions.

To deliver fast, flexible and reliable water models that can be deployed and managed in a controlled operational environment, while ensuring appropriate quality, explainability and integration with existing systems, the programme aims to join forces with research institutions, industry partners and start-ups. Beyond water modelling, the programme is also exploring AI- and data-driven tools that support operational forecasting workflows.

Because the solution space is still exploratory, Rijkswaterstaat uses a market consultation to explore the state of the art before defining a follow-up assignment.

2 The project and market consultation

2.1 Context

The Water Management Centre Netherlands (WMCN) is responsible for operational water forecasting and water information services in the Netherlands. To fulfil this role, WMCN with the support of other RWS-departments produce forecasts of water levels, river discharges, coastal conditions, and other hydrological variables, and issue warnings when necessary.

Forecasters continuously analyse observations, model outputs, and apply expert judgment to assess current conditions and predict future developments. Although the availability of data continues to improve, the interpretation of this information becomes increasingly complex.

Producing a reliable forecast requires expert knowledge to assess model performance, interpret uncertainties and combine information from multiple sources. Building this expertise takes years of operational experience. At the same time, the organisation increasingly faces changes in team composition as employees move between roles and departments more frequently than in the past. As a result, operational expertise needs to be continuously transferred, maintained and embedded within teams. The operational challenge is therefore twofold: the amount of information keeps growing, while the expertise required to interpret it is becoming scarcer.

2.1.1 Findings from user stories

An analysis of user stories across the forecasting domains reveals several recurring themes. Users experience that current systems and models provide insufficient support for their daily work and decision-making, particularly in situations with high time pressure and uncertainty. The related themes (in no order, see Appendix A for all themes and more details) are:

1. Reliability and explainability – predictions are sometimes inaccurate, especially in extreme situations or around critical thresholds, and it is often unclear why a model produces a certain outcome or deviation;
2. Dealing with uncertainty – uncertainty is central to all domains but is currently insufficiently visualised and hard to translate into decisions; users therefore add their own safety margins, and see a need for probability-based information (e.g. not only the expected water level, but also the probability of exceeding a critical threshold);
3. Lack of integration and system thinking – models, tools and data sources are fragmented, making it hard to obtain an integral view of the water system and to understand interactions between its parts;
4. Data quality – gaps in measurements, uncertainties in input data and limited validation options undermine the reliability of models and forecasts;
5. Workload, efficiency and automation – collecting, checking and combining information is largely manual and time-consuming, which increases workload and error risk, especially under time pressure;
6. Uncertainty in (future) extreme events – extreme events occur rarely but have major impact; users need scenario analyses, insight in bandwidths and support to interpret worst-case situations, even more because climate change increases their frequency and intensity.

AI and data-driven developments may provide opportunities to support forecasters in this process and improve the efficiency, consistency and transparency of forecasting operations.

2.2 Scope

The market consultation focusses on the CAG River Team (Crisis Advisory Group Rivers) within Watermanagementcentrum Nederland (WMCN)¹.

This team is responsible for monitoring and forecasting river conditions in the Rhine and Meuse basins, providing operational forecasts that support water management, flood management, drought response and navigation. They provide forecasts for the discharge at Lobith (Rhine) and Sint Pieter (Meuse), particularly during extreme hydrological conditions.

Two user roles are relevant for this market consultation:

1. **The hydrological forecaster:** An operational user responsible for producing and communicating forecasts based on model results, observations and available supporting information. In this document also referred to as forecaster.
2. **The senior hydrologist:** A domain expert who supports forecasting and decision-making through expert knowledge and contextual understanding.

The following six user needs within the operational forecasting process were constructed, based on the user stories.

- | | |
|-------|---|
| UR-01 | As a forecaster, I want the system to <u>identify, prioritise and summarise the most relevant information</u> , so that I can quickly assess the current and expected situations from a single integrated overview. This includes time-series forecast and observation data from internal data like RWsOS, combined with relevant information from external weather and forecasting services. |
| UR-02 | As forecaster, I want access to <u>relevant historical forecasting</u> situations and <u>previous model performance</u> , so that I can benefit from past experiences when assessing the current forecast. |
| UR-03 | As a forecaster, I want clear <u>insight into forecast uncertainties</u> , like model disagreement, so that I can assess the quality and reliability of a forecast. |
| UR-04 | As a forecaster, I want the system to <u>detect and highlight potential data quality issues</u> in forecasts and observations, such as missing, delayed or inconsistent data, so that I can take them into account when interpreting forecasts. |
| UR-05 | As a forecaster, I want <u>forecast outcomes (decision information) and model behaviour to be explained</u> in a transparent and understandable way, including the dominant drivers behind a prediction, so that I can understand and communicate the forecast. |
| UR-06 | As a senior hydrologist, I want to <u>provide feedback</u> and domain-specific knowledge (line of reasoning, e.g. "redeneerlijn") to the system, so that expert knowledge can be reused and applied across forecasting situations. |

¹ [Teams en taken binnen het Watermanagementcentrum Nederland](#)

The Forecast Assistant should focus on supporting expert judgement rather than replacing it. Thereby it aims to improve the efficiency, transparency, and consistency of forecasting operations and focuses on solutions that assist hydrological forecasters and senior hydrologists in accessing, interpreting and applying information during operational forecasting activities.

The development of new or adjustment of existing forecasting models falls outside the primary scope of this market consultation.

Participants may utilise information from internal Rijkswaterstaat systems (e.g. RWSOS) and other relevant internal or external data sources.

2.3 Procedure market consultation

2.3.1 Goal of the market consultation

The goal of the market consultation is to gain insights into innovative potential solutions for a Forecast Assistant that provides forecasters with the right information effectively and efficiently, and to give participants the opportunity to present their proposals with Rijkswaterstaat and the water sector.

2.3.2 Procedure

Participants are invited to submit a market response describing how AI- and data-driven technologies could be applied to assist operational water forecasting.

Rijkswaterstaat will organise a digital information meeting (MS Teams) to provide a further explanation of the 'how and why' of this market consultation on 27 October at 2.00 p.m. (CET).

You can register for the information meeting via an email to aiwam_forecast_assistant@rws.nl up to and including 23 October.

Questions about this market consultation can also be submitted via the same email address: aiwam_forecast_assistant@rws.nl up to and including 2 November. Rijkswaterstaat will answer the (anonymised) questions in a Summary of Questions and Answers on TenderNed, which will be published no later than 5 November 2026.

Participants are requested to submit their response no later than 11 November to wvl-aanbestedingsdocumenten@rws.nl, stating "99999 Forecast Assistant";

Rijkswaterstaat is eager to get your organization's response. Participants are encouraged to:

- Provide their responses to the questions in Section 4, using the template provided in Appendix B.
- Include a brief description of their proposed solution and vision.
- Keep the overall submission concise, with a maximum of 10 pages in Arial font size 10, including annexes and illustrations, but excluding the cover page.
- Include a one-page summary. This will be used in case needed for selection of six presentations.

2.4 Conditions of the market consultation

- Rijkswaterstaat observes the principles of non-discrimination and transparency, as referred to in the Dutch Public Procurement Act 2012 (Aanbestedingswet 2012), throughout this market consultation.

- Rijkswaterstaat has included information in this document to the best of its knowledge at the time of publication. Information from this market consultation will be used to make a better assessment of the intended procurement.
- All relevant information required to prepare a response will be provided in the procurement documents.
- Rijkswaterstaat will use the insights gained from the market consultation (where relevant) in the preparation of a future procurement and the procurement documents. Rijkswaterstaat reserves the right not to use these insights, or to use them only in part.
- Information in this market consultation may therefore differ from information provided later in the context of any intended procurement.
- This market consultation is not an invitation to submit a tender for any future procurement.
- Rijkswaterstaat reserves the right to amend the planning outlined in this document at its own discretion, and/or to terminate the market consultation process in whole or in part.
- The information provided to Rijkswaterstaat through this market consultation will be treated as confidential and will not be used for any purpose other than gaining market knowledge to arrive with better procurement documents.
- Rijkswaterstaat does not offer any compensation for costs incurred or to be incurred in connection with this market consultation.
- By participating in this market consultation, the interested market party declares that it agrees to all the conditions stated above.

2.5 Presentation at the DigiShape event

One of the objectives of AIWam is sharing knowledge, therefore Rijkswaterstaat invites participants to present their solution/vision at the DigiShape event on 19 November. Presentations offer an opportunity to discuss proposed approaches with potential end-users and water-sector experts, and to receive valuable feedback. Presenting is optional but strongly encouraged.

Presentations have a maximum of seven minutes, followed by a short opportunity for questions (maximum three minutes).

Participants who wish to present are requested to register via email to aiwam_forecast_assistant@rws.nl no later than 11 November 2026.

2.5.1 Selection for a presentation

Because of the full agenda of this day, a maximum of six presentations can be accommodated at the DigiShape event on 19 November 2026. If more than six participants register for a presentation, Rijkswaterstaat may select based on the extent to which the market response addresses the topics and questions in this consultation. The purpose of the presentations is knowledge sharing and dialogue. Selection for a presentation does not constitute an assessment or judgement of the response.

The selection for a presentation will be based on the one-pager submitted with the market response. All registered parties will be informed of the outcome no later than 16 November.

2.5.2 Poster session

To give every participant the opportunity to showcase their solution, all market parties that have submitted a market response are invited to present their solution or vision on a poster. Participation in the poster session is optional and non-committal.

During the DigiShape event, a dedicated time slot will be reserved in which all visitors can view the posters and ask questions directly to the participants. Further practical details (submission deadline, format, printing arrangements and orientation) will be communicated to all registered participants in due time.

2.6 Planning

Activity	Deadline
Publication of announcement (TenderNed)	Tuesday 20-oct 2026
Registration deadline information session	Monday 26-oct, 13pm
Online information session (MS Teams)	Tuesday 27-Oct, 2pm
Deadline for questions (TenderNed)	Monday 2-Nov
Publication of answers (Notice of Information, TenderNed)	Wednesday 6-Nov
Deadline market response and registration for presentation	Wednesday 11-Nov
Notification of selection for presentations	Monday 16-Nov
Presentation DigiShape-event	Thursday 19-Nov 2026

3 Questions to the market

Rijkswaterstaat invites market parties to respond to the questions below. Parties are free to indicate which questions they answer and in what level of detail; responses to all questions are appreciated but not required. Where a question does not apply to the proposed solution, parties are kindly asked to indicate this explicitly.

3.1 General

3.1.1 Procurement

- PP-01 What form of procurement procedure would best suit this assignment, in your view (e.g. open procedure, innovation partnership, multiple negotiated procedure)? What are the advantages and disadvantages of each option in this context?
- PP-02 What contract duration and phasing (e.g. proof of concept, pilot, operational deployment) would you consider realistic?
- PP-03 What indicative price range would you expect for the proposed solution, per phase? What conditions or assumptions underlie these indications?
- PP-04 What are the expected recurring costs (e.g. hosting, API or model usage, maintenance, data subscriptions), and how do these scale with usage?

3.1.2 Project organisation

- PO-01 What project set-up would you recommend for a development trajectory of this kind (e.g. agile, co-creation with end users, staged gating)?
- PO-02 What is needed from Rijkswaterstaat to make the project succeed (e.g. data access, availability of forecasters, decision moments, test environment)?
- PO-03 What expertise and roles are needed to realise and operate the proposed solution (e.g. data scientists, ML engineers, domain experts, DevOps)?
- PO-04 Have you previously developed, or are you currently developing, a solution that could be applied to this assignment? If so, please describe it briefly, including its current maturity and the context in which it was developed.
- PO-05 To what extent would you build on open-source components or existing frameworks, and what does that mean for IP, maintainability and vendor lock-in?

3.1.3 Risks

- RI-01 What do you consider the main risks of this type of solution (technical, organisational, operational), and how would you mitigate them?
- RI-02 What legal aspects should be considered (e.g. intellectual property of models and data, liability, use of open-source components)?

3.2 Questions on user requirements:

3.2.1 Questions on user needs:

- UN-01 Are there user needs that, in your view, are missing from this list?
- UN-02 How would you ensure that the solution supports expert judgement rather than replacing it?

3.3 Functional capabilities and consultation questions

3.3.1 Information integration and reasoning

Operational forecasting requires information from multiple sources to be combined into a coherent assessment of the current and expected situation, including situations characterised by limited historical precedent or high operational impact (extreme events).

The most important sources available within the operational environment of the CAG River Team include (this list indicative):

Time-series based data:

- model results (e.g. RWSOS² / Delft-FEWS³ forecasts and simulations, including ensembles); observation data (e.g. water levels, discharges at Lobith and Sint Pieter, meteorological data);
- external weather and forecasting services (e.g. commercial platforms, national meteorological services);
- historical forecasting situations and model performance records.

Text-based data:

- (situational) reports and messages (e.g. warnings, upstream notifications, news feeds);
- Literature like technical reports, papers, thesis etc. providing context.

Rijkswaterstaat is looking for insight into how market parties could connect, combine and present these sources into a coherent picture that supports forecasters in understanding the dominant drivers behind a forecast and assessing the reliability of the information.

The output should help users build and communicate using a transparent reasoning process ("redeneerlijn").

Participants are asked to elaborate on this topic, addressing the following subjects:

- Which information sources you consider most valuable, and why — and which additional (types of) data sources you would recommend including.
- Which tools and APIs would be needed, and for which purpose.
- How information from different source types could be combined into a coherent line of reasoning ("redeneerlijn") for the forecaster.
- How forecast drivers, assumptions and supporting evidence could be identified and presented.
- How comparable historical situations could be identified, and which characteristics should be used to determine similarity.

Met opmerkingen [AD3]: Consistent with other chapter titles

² [RWSOS : samenhangende operationele systemen van Rijkswaterstaat | Rijkswaterstaat Publicatie Platform](#)

³ [About Delft-FEWS - DELFT-FEWS Documentation - Deltares Public Wiki](#)

- How a solution could provide reliable support during rare or extreme situations, and how this reliability could be validated.
- The main technical and practical challenges you foresee.

3.3.2 Uncertainty and data quality

Forecasting depends on understanding both forecast uncertainty and the quality of the underlying information. Sources of uncertainty relevant to the operational forecasting process include differences between model forecasts, ensemble spread within a single forecast, changes between successive forecast runs, and uncertainty arising from boundary conditions, observations or external inputs. In addition, the reliability of a forecast depends on the quality of the underlying data; relevant data quality issues include missing, delayed, inconsistent or physically implausible observations and forecasts.

Rijkswaterstaat seeks insight into how such uncertainty and data quality information could be assessed, communicated and incorporated into the forecasting process, and how these supports forecasters in interpreting forecasts and understanding their limitations.

Participants are asked to elaborate on this topic, addressing the following subjects:

- How uncertainty and data quality could be assessed and communicated within the forecasting process, including their effect on forecast interpretation.
- Which indicators, comparisons or visualisations would be most useful for users.

3.3.3 Expert feedback and human oversight

Human expertise and the reuse of expert knowledge remain essential within the operational forecasting process. The assistant supports the forecaster, but the final assessment remains the responsibility of the forecaster. The senior hydrologist role is to support forecasters with the correct line of reasoning ("redeneerlijn"). The solution should therefore allow experts to interact with, steer and complement the system, and to embed their knowledge for reuse.

Rijkswaterstaat seeks insight into how market parties would organise this human oversight and knowledge reuse.

Participants are asked to elaborate on this topic, addressing the following subjects:

- How authorised users can review, correct, reject or supplement system output, and at which point human approval should be required.
- How the reasoning process can be adapted during runtime based on user feedback, and what capabilities are needed to support this.
- How expert knowledge ("redeneerlijn") could be captured, governed and reused across forecasting situations, so that forecasters can apply it independently, and what quality requirements should apply to it.
- How failures, unavailable services, conflicting results and operational or security restrictions should be handled.

3.3.4 Output and reporting

Operational forecasting regularly involves communicating forecasts and their underlying reasoning to water managers, crisis teams and other stakeholders. The solution should therefore support the creation of operational and communication materials during forecasting activities.

Rijkswaterstaat seeks insight into which output and reporting capabilities would best support this.

Participants are asked to elaborate on this topic, addressing the following subjects:

- Which output and reporting formats you foresee and what would best support operational workflows.
- Which source references, issue times, warnings and uncertainty information should accompany an output.
- How generated content could be reviewed, edited and approved.
- How different versions of an output could be compared and traced.
- Which export and integration options should be considered.

3.4 Technical requirements and consultation questions

The topics below are intended to obtain market input on the technical requirements and conditions that should be considered in a possible future RFP. Participants are invited to describe the technical design, requirements and limitations of their proposed solution, including the following aspects:

3.4.1 Architecture and integration

The proposed solution may consist of multiple components, data sources and services that need to work together, in interaction with existing Rijkswaterstaat systems.

Rijkswaterstaat seeks insight into suitable architectures, integration approaches and dependencies.

Participants are asked to elaborate on this topic, addressing the following subjects:

- Which architecture would be suitable for the proposed capabilities and what requirements and constraints should be considered.
- Which components or services should be provided by Rijkswaterstaat, third parties or the suppliers.
- Which hosting and deployment options should be considered, and which components should operate within a Rijkswaterstaat-controlled environment.

3.4.2 Data, security, traceability and AI governance

The solution is expected to process data from multiple sources and may use AI technologies to support operational forecasting. A secure, transparent and controlled operation is therefore essential.

Participants are asked to elaborate on this topic, addressing the following subjects:

- What requirements are needed regarding data management, information security, traceability and access control.
- Which requirements should apply to the responsible, transparent and controlled use of AI, including version management, and the distinction between retrieved information, expert knowledge, calculations and AI-generated interpretation.
- How the use of Rijkswaterstaat data, user input, outputs and feedback for AI model training or improvement should be handled.
- Which of these aspects you consider most important, and which additional requirements or considerations should be included.

3.4.3 Testing and validation

The solution should be tested and validated to demonstrate that it performs as intended and supports operational forecasting activities. Rijkswaterstaat seeks insight into how such testing and validation could be organised.

Participants are asked to elaborate on this topic, addressing the following subjects:

- How factual accuracy, source attribution, retrieval relevance, uncertainty communication and data-quality detection could be validated.
- How validation could use representative historical forecasting situations, ensuring that no information is used that was unavailable at the original forecast issue time.
- Which acceptance criteria and expert-review procedures could be applied.
- How testing and revalidation could be organised following significant model, configuration or software changes.

3.4.4 Deployment, operations and maintenance

The solution should be deployable, monitored, maintainable and adaptable throughout its lifecycle. Rijkswaterstaat seeks insight into the deployment, operational and maintenance requirements that should be considered for a future RFP.

Participants are asked to elaborate on this topic, addressing the following subjects:

- What deployment, hosting, integration and portability considerations should be taken into account.
- How operational monitoring of system health, data freshness and errors could be organised.
- How continued operation could be ensured when data is missing, delayed or conflicting.
- What operational support, maintenance and knowledge transfer would be needed, and how dependencies on proprietary technologies, external services and suppliers could be managed.
- How the solution could scale to other forecast domains.
- What factors are expected to have the greatest impact on implementation effort, operational complexity and costs.

Appendix A Analysis of user stories

When analysing the user stories, several recurring themes emerge. Across the various domains, there is dissatisfaction with the speed, accuracy and reliability of model outputs. Users experience that current systems and models provide insufficient support for their daily work and decision-making, especially in situations where time pressure and uncertainty play a significant role. The main recurring themes are explained below (the order does not reflect priority).

A.1 Reliability and explainability

One of the most frequently mentioned bottlenecks is the lack of trust in model outputs. Predictions often prove inaccurate, particularly in extreme situations or around critical thresholds. For example, predictions of water levels or waves regularly show an incorrect peak height or timing, which has direct consequences for operational decisions such as closing flood barriers or admitting shipping traffic.

In addition, insight into why a model produces a particular outcome, or why deviations occur, is often missing. It is difficult to explain in hindsight why a forecast deviates from measurements or other models, while this is precisely what matters for interpreting results and being able to account for decisions.

This makes it complex for users to interpret model results properly. There is therefore a need not only for better model performance, but above all for models that provide insight into their own quality, uncertainty and behaviour, so that users can better assess when an outcome is reliable and when it is not.

A.2 Dealing with uncertainty

Uncertainty plays a central role in all domains but is currently made insufficiently visible and applicable. Although multiple model outcomes or bandwidths are often available, users find it difficult to interpret these and to incorporate them into their decision-making.

As a result, users in practice add their own margins or safety buffers to absorb uncertainties. This happens, for example, in decisions around critical thresholds, where extra room is built in as a precaution. There is a need for an explicit and consistent way of representing uncertainty, in which not only the spread is visible, but also what it means for the probability of taking measures. For example: not only the expected water level, but also the probability that a critical threshold will be exceeded. This calls for a shift from deterministic predictions to probability-based information that is directly usable in practice.

A.3 Speed and computational capacity

The speed of models and the availability of results form a structural bottleneck. Models often run too slowly and are not updated frequently enough to align well with operational practice. As a result, information may already be outdated when used for decision-making.

In addition, long computation times make it difficult to respond quickly to changing circumstances. Calculating alternative scenarios or additional analyses often takes too much time, while in practice there is a strong need for this — for example in impending situations where one wants to know the effect of a hydraulic structure failure or a suddenly changing weather pattern.

Users therefore need faster and more flexibly deployable models, with more frequent updates and the ability to have results available closer to the moment of decision-making. This applies both to short-

term applications (such as monitoring high water on an hourly basis) and to longer-term applications such as preparing for potential events.

A.4 Lack of integration and system thinking

Another important theme is the lack of coherence between different models and information from other software packages and data sources. Users work with multiple tools and information sources that often do not connect well, leading to a fragmented picture of reality.

As a result, it is difficult to obtain an integral overview of the water system and to properly understand the relationships between its different parts. For example, decisions are often made based on information at one location, while the effects in other parts of the system, such as the hinterland, are insufficiently visible.

It is also difficult to view different processes, such as water levels, waves and currents, in relation to one another. This hampers the understanding of complex situations in which multiple factors play a role simultaneously. There is therefore a need for a more integrated approach in which different models and datasets come together in one consistent and coherent whole.

A.5 Difficult translation of model output into decision information

Model outputs often align insufficiently with the information needs of users in practice. The output is usually technical in nature and still requires extensive interpretation before it can be used in decision-making. Users must make the translation from model outcomes to concrete actions themselves — for example, determining whether a flood barrier should be closed, how long an obstruction will last, or whether maintenance can safely proceed. This translation is complex and requires experience, while decisions often have to be made under time pressure.

In addition, information about the impact of a prediction is often missing. Users want to know not only what the expected value is, but above all what this means for the system and their actions. Think of consequences for the safety of a dike, the accessibility of a navigable waterway, or the deployment of operational teams.

The absence of this translation leads to uncertainty and inefficiency and increases the dependence on expert judgement. There is therefore a need for information that not only describes what is happening, but above all what it means for practice: concrete, impact-oriented decision information that is directly usable.

A.6 Data quality

The quality of available data forms an important foundation for the reliability of models and predictions but is experienced by users as insufficient. There are gaps in measurement data, uncertainties in input data, and limited possibilities to properly validate model outputs against measurements.

In addition, relevant data is not always available at the right locations or in the right resolution. In some cases, users must work with information that is too coarse or not location-specific, forcing them to make assumptions anyway.

A further issue is that in extreme situations little reliable data is often available, while the need for good information is greatest precisely then. This underlines the importance of better, more consistent and better-validated data sources as the foundation for model development and application.

A.7 Workload, efficiency and automation

The current way of working leads to a high workload and inefficiency. Users spend much time collecting, checking and interpreting information from different sources. Combining model outputs, measurements and external information requires manual work and a great deal of expertise.

In addition, monitoring model performance and correcting deviations takes a lot of time, at the expense of other tasks. In situations with time pressure, such as high water or storms, this can lead to extra stress and an increased risk of errors.

There is therefore a need for more automation and support in the analysis and decision-making process. Systems should not only provide information, but also actively help to interpret it and to prepare decisions. This can reduce workload and improve efficiency.

A.8 Uncertainty in (future) extreme events

A specific and recurring point of attention is the uncertainty surrounding extreme events. These situations occur relatively rarely, but have major impact, which makes them difficult to model and predict.

Users indicate that there is little insight into how models perform under extreme conditions, such as severe storms, prolonged drought, or combinations of different factors. In addition, good references or historical comparisons to place these situations in context are often missing.

Due to climate change, the frequency and intensity of such events is increasing, causing uncertainty to grow further. This increases the need for better scenario analyses, insight into bandwidths, and support in interpreting possible extremes.

Users want to know not only what the most likely situation is, but precisely also what may happen in the worst case, and how they can prepare for it.