Scenario Analysis

Real-time Hydrological Forecasting

Flood
Scenario Analysis

Real-time Hydrological Forecasting
Objective
Assignment

On Deltares’ instructions a number of future scenarios were drafted concerning ‘Real-time Hydrological Forecasting’ for the year 2025.

The purpose of these scenarios is to support strategy development.

Supervision and the Team of Writers

The work was coordinated and supervised by Curiozy on Deltares’ instructions. Curiozy and Deltares jointly drew up a plan of approach. Curiozy coordinated the process and was responsible for its methodical supervision.

The Report

This report presents five scenarios on ‘Real-time Hydrological Forecasting’ for 2025. These scenarios provide tools for analysing the relationship between various developments (demographic, economic, socio-cultural, technological, environmental and political/governmental) and Real-time Hydrological Forecasting.

These developments were given particular attention. In addition, the scenarios provide insight into the effects on knowledge development, national and international cooperation, and the market and its products.

1 CURIOZY is a consulting firm designing and facilitating forward-looking national and international cooperation projects by which teams can translate aspects of global and local issues into innovative, scalable solutions and visions of the future. See also http://value.curiozy.net.
Introduction
This is a Scenario Analysis concerning ‘Real-time Hydrological Forecasting’. Deltare developed five future scenarios for the year 2025.

The development of these five scenarios was coordinated and supervised by Curiozy. The three writers from Deltare were supported by writers from Rijkswaterstaat (Directorate-General for Public Works and Water Management) and Mureau Risico Weeradvies (weather consultancy).

Prior to writing the five scenarios, a brainstorming session was held with some 30 experts (listed here) from different backgrounds. The meeting consisted of three rounds of discussions in which current developments, expected developments and so-called wildcards were studied and charted. Each round involved four subgroups. Each subgroup included one writer from the scenario-writing team. In this way the writers gained both direct and indirect information. After each round of discussions the key points were summarized and discussed in plenary sessions.

During a ‘challenge week’, the team of five writers developed the scenario system, the scenarios themselves as well as their initial effects on knowledge, cooperation and the market. Each writer was responsible for one scenario. Together, the scenarios covered almost all the themes that were introduced by Deltare and the experts at the brainstorming session. At the end of the challenge week the scenarios were presented to representatives of Deltare.
Scenario System

Partly based on information from the aforementioned brainstorming session, two factors were determined:

- Government focus
- Technology focus

Three relevant, independent viewpoints were formulated with regard to each of these two factors. Of the nine options, five were selected to form the basis for the scenario system. The scenarios and insights arising from this system are based on expert judgement and therefore do not constitute formal strategy choices.

The scenario system is represented schematically on page 11.
Methodology

The methodology adopted for this Scenario Analysis does not follow the linear approach found in the more traditional way of developing analyses of possible futures.

First of all, a brainstorming session was held with approximately 30-40 experts from different backgrounds. The meeting consisted of three rounds of discussions in which current developments, expected developments and so-called wildcards were studied and charted. Each round involved four subgroups. Each subgroup included one writer from the scenario-writing team as participant. In this way the writers gained both direct and indirect information. After each round of discussions the key points were shared, summarized and discussed in plenary sessions.

Next, the scenarios were developed during a ‘challenge week’, in which the team of writers developed the scenario system, the scenarios themselves and the initial effects. Each writer was responsible for one scenario. Together, the scenarios covered almost all the themes that were introduced by the experts at the brainstorming session. At the end of the challenge week the scenarios were presented to Deltares representatives.

The client determined in advance what objectification and effects were desired as part of the scenarios to be developed. This enabled the client to compare the different scenarios with regard to a possible impact on its policy and/or strategy.

The scenario methodology used, which was developed by Curiozy in collaboration with representatives of the Ministry of Security and Justice (2016), is based on crossing two orthogonal factors that emerged from the brainstorming session as important developments with both an uncertain outcome and a high impact.

For the development of scenarios, the two factors that were selected, were technology focus and government focus.

In the methodology, two or three viewpoints are defined per factor. In the scenario development for Deltares, three viewpoints were defined for each factor.

They are self-contained viewpoints which have their own characteristics. The two factors, each with their own viewpoints, provide a matrix of possible future scenarios. Of the nine possible combinations, five scenarios were selected based on expert judgment of the five writers.

On pages 10 and 11 the two intersecting factors and their corresponding viewpoints are shown.
Factors and viewpoints

Government Focus

Traditional Government

Regulatory Government

Glocal

Technology Focus

Opportunistic

User Oriented

Protectionist

Scenario Analysis 'Real-time Hydrological Forecasting'
Introduction

Scenario system

Government Focus

Traditional Government

Regulatory Government

Glocal

Caring Government

Conditional for the development of a diversity of commercial activities

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

International, technocratic interest and geographic networks for new opportunities

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

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

The Moat

Government Focus

Opportunistic

User Oriented

Protectionist

Scenario Analysis ‘Real-time Hydrological Forecasting’
Scenarios in Brief
Political parties increasingly focus on reduction of the size of government, cost savings and greater efficiency, more so than in the past decade. As a result it has been decided that government will still be responsible for Real-time Hydrological Forecasting but will no longer have any executive tasks in this regard. These tasks will be outsourced. The same is true for research. The development of knowledge will be delegated to universities and independent centres of excellence, while applied research will be left to the private sector.

This offers many opportunities for innovation. Major and minor players in the market can take advantage of the latest technological developments such as Big Data, other computer technologies and smart measuring methods. This has led to an economic boost as a large number of companies has become active in the market.
The strategic partnership of Rijkswaterstaat and the Water Boards in the provision of water information has become very successful. Together they provide the public and professionals with pooled information, tailoring their information and advice to the target groups using active contributions from users.

In 2025, the compact government will outsource hydrological forecasting to private parties. As forecasts are key elements of the government’s core function — i.e. warning the population about hazardous situations — forecast providers will have to meet strict requirements, also in relation to the protection of citizens’ privacy. This means that unrestricted use of Big Data will no longer be possible.
The start-up society is a society formed by citizens, start-ups and multinationals – without a strong government. Innovation flourishes and technological development is faster than ever, mainly driven by the growing amount of available data. Citizens and businesses are looking for services in which information is translated into impact, i.e. impact on themselves and impact on society. To meet this demand, there will be more and more transdisciplinary exchange of knowledge. Using new visualization methods, the impact can be communicated to a broad group of people. Rising unemployment will lead to higher self-reliance among citizens. Looking after each other (perhaps out of necessity) will be the rule rather than the exception.

The world in 2025 will have become much more open. Globalization will be back. China and Russia will join the open data and open source movement, and – after the protectionist years of the last decade – the US and the EU will also fully participate again. New, small and smart sensors will provide data on all aspects of hydrology. Big data will have grown. Global companies such as Google will make global hydrological predictions based on high-resolution hydrological models. Research at local universities and research institutes around the world will help to improve those predictions. Governmental agencies such as Rijkswaterstaat will therefore have stopped delivering hydrological predictions. In a more urban but also international world, many small and innovative businesses and citizens' initiatives will combine these predictions with Big Data, and will provide a multitude of technical products and services aiming at satisfying local information needs.
Regulatory Facilitator
Summary

Political parties focus even more on the reduction of the size of the civil service, cost savings and greater efficiency than in the past decade. As a result it has been decided that government will still be responsible for Real-time Hydrological Forecasting but will no longer have any executive tasks in this regard. These tasks will be outsourced. The same goes for research. The development of knowledge will be delegated to universities and independent centres of excellence, while applied research will be left to the private sector.

This offers many opportunities for innovation. Major and minor players in the market can take advantage of the latest technological developments such as Big Data, other computer technology and smarter measuring methods. This has led to an economic boost as a very large number of companies has become active in the world of water.
The Path to 2025

Government policy between 2017 and 2025 emphatically states that the number of civil servants should be reduced. Vigorous implementation of the policy runs in parallel with the new style of government first introduced by President Trump in the USA. The government no longer has any executive tasks but continues to bear responsibility. This change results from the fact that more and more small businesses have entered the weather and water market and are potentially able to deal with new technological developments in an innovative and decisive manner. The Royal Netherlands Meteorological Institute (KNMI) and Rijkswaterstaat outsource not only tasks such as measuring and predicting but also 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 what is and what is not covered by the term ‘safety’. For example, back in the nineties, there was not a clear distinction between commercial and public tasks in the world of weather. In 2020, the government decided that the provision of safety (in the fields of hydrology and meteorology, and also climatology) could be left to parties other than the government, provided this protection was well documented and provided the companies 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 commercial company can go bankrupt, or may shift its focus), it is found even more important that start-ups generate innovation. The government 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 and applying data analytics, were transferred to other organisations. As research has a long-term component of 3-5 years, or even longer, finding a good solution was essential. That is why it took until 2020 before all this was enshrined in law and before a start could be made with separating 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.
Situation in 2025

A Double Threat

April 16, 2025. The weather is remarkably quiet – a typical calm after the storm. Journalist Willem Mes is visiting the River and Sea Water Board to talk about the near-storm and near-flood last night. It was the first time that an extreme weather warning was issued in the new structure in which the task of warning has been transferred from the government to a commercial party. So there is sufficient reason to discuss last night’s events with one of the stakeholders. Mes therefore made an appointment with water manager Peter Roggeveen. Peter has worked for the water board for 20 years and has experienced quite a few extreme weather warnings. He is still a bit sleepy and recovering from the stress of the past few days. Fortunately, the threat of flooding did not materialize yesterday. Water levels far above the flood alarm level had been forecast for many days but ultimately this limit was never reached. There had not only been a high risk of flooding by the sea (there was a lot of wind) but also by the rivers (there had been a lot of rain upstream and – because of the sudden rise in temperature – a lot of melt water had also entered the rivers). A unique situation in which the new system was severely tested. Roggeveen explained that this meant that the water board had to do a lot of dike monitoring and inspections, and had to be on the alert to take emergency measures. Even preparations for the evacuation of the inhabitants of the area had been made. That had been a very tense moment. Ultimately, this drastic measure proved to not be necessary.

The Government as Commissioning Authority and Guardian

It all had gone well. “I have to admit I was worried about whether a commercial company would be able to handle it, but they did well. Communications and explanations could have gone a bit better, though. They clearly lack some hydrological knowledge,” said Peter. In the new system, the warnings are issued by a single commercial party called Weather Water Services. This major weather and water services provider had won the tender. They were to deliver both the weather and water forecasts, the latter including river and sea levels. All in one. They even bore the responsibility for closing the flood barriers (under the supervision of, and financed by, KNMI and Rijkswaterstaat). Weather Water Services was chosen because it was part of a large Big Data group. They had a great deal of expertise with Big Data and would be able to improve forecasts by linking user data to meteorological and hydrological data in a smart way. Willem Mes wondered whether their methods would also work for extreme cases. Another question was whether the new company would be able to communicate the message well and clearly. Getting a group of mathematicians together was no guarantee that the product would prove useful in an extreme situation.
Mathematicians Making Forecasts

From the outset there had been commotion about the fact that the forecast would not be issued by the government. “That can’t go well” and “Who will be responsible for errors?” were a few of the comments. In Peter’s experience it was a good thing that the forecasts were now coordinated and issued by a single organization. This should also lead to more efficiency. He was less enthusiastic, however, about the large amount of numbers he found on the bespoke website every day. It was all statistics on the screen. How should such a forecast be interpreted? And what action should one take? These were the issues he had struggled with.

The risk of flooding had been estimatd to be high in the first forecasts and even increased until two days before the events, when the risk had decreased again. That was all very confusing. Ultimately, flooding had not occurred. Each time the experts explained things extensively during internet sessions. But the explanations themselves were not very satisfactory. “They’re all nerds,” says Roggeveen. “They know a lot about maths, but they cannot explain the consequences for the water levels. The question did not even seem to interest them. “That’s the outcome produced by the system,” they would say. Ultimately, it all went well, although Peter had to ask quite a few questions before he got the right advice.

More Attention to Domain Knowledge

Journalist Mes wrote it all down while Roggeveen took another sip of his coffee. “Now comes the boring bit, that is to say, the evaluation,” Roggeveen said. KNMI and Rijkswaterstaat will come tomorrow. They will issue a comprehensive report in which both parties will state their independent judgements, not just about the forecasts, but also about whether the procedures were followed properly. Roggeveen did not particularly like writing reports but he had to admit that they were useful. It is good to have independent parties such as KNMI and Rijkswaterstaat. And they also gave you the opportunity to think about improvements.

Mes asked whether he saw any improvements. “Yes, sure, they are bound to come.” There was no way back, that was clear. He has fond memories of the early days when the much smaller hydrological and meteorological services regularly invited water managers to attend courses. You learned how the forecast was produced, what issues hydrologists and meteorologists were struggling with, and how you could assess whether a forecast was good. That was what he would advise KNMI and Rijkswaterstaat. More hydrologists and meteorologists would have to be hired to secure domain knowledge. More emphasis needed to be placed on improving the transparency of forecasts.

Willem Mes closed his laptop. This would be a nice story to publish in the newspaper tomorrow.
Developments

Demography
People in the hydrological profession change jobs quickly. The free movement of people within Europe (guaranteed by the EU) enables large-scale exchange of researchers, comparable to the situation in the United States. People have a realistic economic picture of the value of the work. Salaries in the private sector are lower than those paid by the government. The government therefore provides temporary salary guarantees to people who make the transition from government employment to private sector contractors.

The retirement age in 2025 is 70 years. There is a large group of older people available in the labour market. As there is an emphasis on production and efficiency, it is a challenge to keep this group in work. The government encourages companies to employ and retain older employees. Their experience can be utilized in many new ways, for example, by using them in training programmes.

Economy
In the US, the role of the government has been reduced, and universities have much tighter research budgets. For example, compared to 2015, funding for climate research has halved, and other scientific research has also been reduced. This has created opportunities for Europe. The European government, for example, does consider climate research relevant and facilitates a lot of research through funding. As a result, employment opportunities for researchers in Europe have increased. In 2025, in the context of the free movement of people, much routine work (such as ICT) has been outsourced to low wage countries in Eastern Europe. This has put pressure on employment in the Netherlands but is in line with the principles of the free market economy.

Fundamental and applied research is thus growing in Europe, but under strict conditions. It is expected that the liberalization of the academic world of research and forecasting will stimulate the economy and that, after the initial economic stagnation due to the transition in the years after 2024, the rise of all kinds of new companies will lead to economic growth.

Socio-cultural Developments
Working in the private sector means one is joint responsible (directly or indirectly) for generating sufficient amounts of revenue. Deadlines are strict. It is a different culture. There is also less certainty. Companies come and go. This means that mobility in the labour market is high, and there are more jobs, more fresh ideas, and there is more innovation.

Continued automation has led to a further change in the role of experts in the prediction process. Auto-generated texts, for example, have simplified the lives of hydrologists. However, there is a need for people who can explain what forecasts means in concrete terms. The hydrologist has become a communicator. The work has changed dramatically. For some, it has become less exciting while for others, it has become more challenging.
All forecasts are produced by a single private company: Weather Water Services
Technology

As a result of increasing computational power, global water and weather models now have a resolution of 2 km, while regional models have a resolution of 100 m. These resolutions are increasingly making use of ensembles (multiple simultaneous runs to estimate uncertainty). Big Data solutions are booming. More and more data is released from people’s homes, so that forecasts can be directly linked to the users’ immediate benefits. The required technology has been further developed. In 2025, new Big Data technology is adding a wealth of information to the numerical models. Satellites and smart dike systems are enabling hydrologists to monitor safety from their offices.

Ecology

Climate change is becoming increasingly visible. There are more heavy rain showers and there is more flooding. The desire to change society through government policy has also become stronger. As a consequence, there is a need in society for local forecasts and recommendations. In 2025, a great deal of attention is paid to adaptation. Houses are built in a sustainable manner. There is a great need for advice on adaptation measures, so there are many opportunities for weather and water research and consultancy services. As increasing urbanization prevents a natural drainage of water, the construction techniques for building individual homes and complete neighbourhoods will be adapted. Sea-level rise is exacerbating this problem, especially for towns and cities at locations where water management is particularly difficult. This offers opportunities for SME because the government stimulates and finances research in this area.

Politics/Governance

Politics in Europe have become much more effective after England left the EU. In the long term, Europe has benefited from Brexit. Additional funds have been made available for innovative research. International cooperation is still a prerequisite for such funding.

The government has clearly indicated which responsibilities have been delegated to Rijkswaterstaat. These include

1. the provision of regular forecasts,
2. the provision of extreme weather conditions and flood forecasts,
3. innovative short-term research, and
4. innovative long-term research.

At the same time, Rijkswaterstaat is expected to outsource the operational aspects of these tasks to the private sector. Rijkswaterstaat will remain responsible for supervision, the drawing up of specification and testing of results.
### Effects

<table>
<thead>
<tr>
<th>KNOWLEDGE DEVELOPMENT</th>
<th>COLLABORATION</th>
<th>MARKET</th>
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<tbody>
<tr>
<td>Domain and local knowledge</td>
<td>Is outsourced but still considered essential</td>
<td>Authorities will need to collaborate to establish rules and regulations</td>
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<tr>
<td>Model development</td>
<td>Is outsourced but still considered essential</td>
<td>Between market players</td>
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<tr>
<td>Forecasting knowledge</td>
<td>Is outsourced but still considered essential</td>
<td>Civic participation</td>
</tr>
<tr>
<td>Decision-making process</td>
<td>Is outsourced and still considered essential, but does not have the highest priority</td>
<td>Long-term collaboration (&gt; 2 yrs)</td>
</tr>
<tr>
<td>Data analytics</td>
<td>Is outsourced but still considered essential</td>
<td>Co-creation, CoP, Networking</td>
</tr>
<tr>
<td>Cross-disciplinary knowledge</td>
<td>Is stimulated by bringing parties together; does not have the highest priority.</td>
<td>Open source</td>
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### Scenario Analysis ‘Real-time Hydrological Forecasting’
In Conclusion

This scenario offers many opportunities for the private sector, where a lot of extra jobs may be created. It should be noted, however, that the government remains responsible for issuing extreme weather forecasts, and will also be accountable for the results. In other words, we still need to make arrangements for single voice forecasting where extreme weather is concerned. In principle, any party can make and issue forecasts. However, in the case of severe weather, government forecasts may not be contradicted. Several Gentlemen’s Agreements have been made about this in the domain of weather forecasting. Such agreements should also be made in the hydrological field. The image of a hands-off government could lead to misplaced expectations in this respect.

The government will have to take care of maintaining hydrological knowledge. Initially, the people responsible for outsourcing will have sufficient substantive knowledge. It is, however, not inconceivable that after a few years, this knowledge will decrease when the experts are no longer employed by the government, but by private enterprise.

The most attractive aspect of this scenario is that, if properly organized, research and development activities carried out by various companies may improve forecasting in an effective, efficient and innovative manner. As research needs to be contracted out, a much more dynamic research process is created, in which research that does not produce any results can be stopped in a timely manner. The associated risk is that only short-term research (<2 years) will be considered and that long-term research will be neglected. This will require additional attention.
Summary

The strategic partnership of Rijkswaterstaat and the Water Boards in the provision of water information is a great success. Together they provide the public and professionals with pooled information, tailoring their information and advice to the target groups using active contributions from users.
The Path to 2025

Collaboration between Rijkswaterstaat and the Water Boards has changed from information exchange to joint information provision. As a result the collaboration between these two bodies intensified in a relatively short time. The underlying idea that it should 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 disappeared 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 made, which are used in a more timely manner. An additional effect is that the 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 pride in the workplace. People want to see the government making positive contributions and performing its tasks actively and visibly. The government has taken on that responsibility with success.
Situation in 2025

RijksWaterschap’s new website went online today [see www.waterinfo.nl]. We are visiting Sjef Saferingen in his new office in Werkendam for a demo and would like to hear his opinion on how the strategic partnership of Rijkswaterstaat and the Water Boards came into being.

In our country’s most beautiful meeting room we have a splendid view of one of the most attractive water areas in the Netherlands: the Noordwaard polder. This place compares to no other in its dependence on the provision of water level forecasts. If the water level exceeds 2.10 m, the entire polder will be inundated to help maintain a safe water level in the surrounding area. Cattle and – if the water level gets even higher – residents will then need to retreat to the mounds that were built in this area 10 years ago. The water level is not that high today, and I can see cows calmly grazing in the meadows below.

Mr Saferingen is a young hardworking official who talks proudly and enthusiastically about the new situation. “Please call me Sjef,” he says when we shake hands.

The close cooperation between Rijkswaterstaat and the Water Boards started more than five years. A complete merger, as the political parties had pushed for after the last elections, was not an option. “Needless reorganizations, relocations, contraction, role changes and so forth were actually prevented by this smart collaboration under the name of RijksWaterschap.” Sjef acknowledges that this name (meaning ‘national water board’) was initially just a temporary working name. When it turned out that all the parties liked it, it became the official name. He further explains that “This developed had already been envisaged when the Netherlands Water Management Centre was established, but it was still too much of a Rijkswaterstaat thing at the time.”
Rijkswaterstaat’s new offices in the Noordwaard polder with the spillways near the Merwede in the background.

Rijkswaterstaat image archive, building: atelierGROENBLAUW
What is the task of the RijksWaterschap? And how has it been given shape and form? Well, each party is still managing its own area, but the main difference is that they have now combined their water reporting. This has improved things considerably in the performance of their own duties, and also for public and professional users. Previously, the measurements and forecasts of the two parties had to be purchased at different locations and water reporting was not always consistent. "In a crisis situation, like when it is high tide, you only want one source of information," underlines Sjef with the severity of a schoolmaster. By combining production (measurement networks, computer models), technical infrastructure, and interpretation and reporting, they were able to achieve a considerable cost reduction.

The five years following the decision were very busy. Sjef, who was involved almost from the beginning, looks back to a good result, but also to a very intensive period. "Initially, funding was difficult and people were not too keen, but later on many proved to have underestimated the technical realization." “But it is now a solid undertaking,” says Sjef. Floating solar cells in the Evides reservoir provide the office and server park with renewable energy, so it is also a green building. Another form of reuse is that an exact copy of the office has been erected in Terneuzen. It is one of the most sustainable offices of Rijkswaterstaat. “It’s exactly what we need.”

With considerable pride Sjef shows me the workplaces and introduces me to the team of technical experts who operate the centre 24/7. In addition to this computing centre, a back-up centre has been established in the Waterschapskhuizen in Amersfoort. Next, we enter the Water Room, the throbbing heart of water reporting. Light, spacious and – surprisingly – only staffed by two people. However, when Sjef walks past the various desks and explains in detail what happens at each location at high tide, during storms, and also during drought periods, we get a good picture of the substantial amount of work that is done here.

Next, we have a look at the website. Water reporting is now prominently focused on the use of the information provided, even more so than before. User-oriented information is the key concept. What information is desired by which user? The menu structure is therefore not arranged in the traditional way, ordered by the various parameters such as water level, flow and wind, but by different areas of use such as recreation, safety, farming, energy and drinking water. In recent years, many users were asked to indicate their real needs and how information and advice might be properly provided. Customer-oriented thinking subsequently led to customer participation. Currently, there are still various user panels that provide feedback and suggestions for improvement on a regular basis. New users are also invited to share their input and wishes with RijksWaterschap. “Only yesterday we talked extensively with farmers in the Eastern part of the Netherlands about management and information concerning the floodplains,” adds Sjef.

A lot of additional expertise was attracted by the team of hydrologists because a much wider range of knowledge is needed to provide the right interpretation and advice regarding the above topics, in addition to producing the best water-level forecasts. “Together with knowledge institutes, we investigated how we could best develop and execute these services.” We then developed the design together with the users. Unfortunately, there were political concerns that the government would again grow as a result of this cooperation and expansion of services. This growth, however, proved to be partly offset by the efficiency resulting from combining forces. In addition, an independent accounting firm calculated that it was actually the improved service that had such a great added value for the Netherlands that the staffing of the centre could easily be
Special water-level forecasts for the Noordwaard area.

http://waterberichtgeving.rws.nl
paid out of the revenue of providing the combined service. Furthermore, the communication lines with the chains of command responsible for safety remain short and unambiguous. “And that makes everyone happier and perform even better”, says Sjef. He then sighs deeply and complains about the fact that he continually needs to justify this to politicians and to lobbyists who want to get their piece of the pie.

The new approach seems to provide an impetus for various initiatives and new services. There is a lot of attention for these projects on the website, and the users are also invited to contribute their ideas. Together with Sjef we have a look at some of these projects, including measurement networks, the risk dashboard, WFD reports, etc. I recommend readers to have a look at the website. “This larger team also enables us to jointly focus on areas of research and innovation which we wish to explore on our own or with the assistance of market parties and knowledge institutes.”

In a fairly new project called ‘Provinces and Cities’, it is studied how the current group may be expanded with cities and provinces, all with the aim of providing users with even better and singular platforms with relevant information and advice. “This project is still in its infancy, but on the other hand, our ‘own city’, the Municipality of Werkendam, has already been fully integrated into the information provision.” This foundation for reporting on the Noordwaard (which falls under this municipality) was laid ten years ago.

The enthusiasm shown in the above projects, which are directly linked to RijksWaterschap, appears to be contagious. The Water Boards and Rijkswaterstaat seem to work well together in many more areas. For example, the tender for a new bridge over the Merwede has been made together with the Water Boards. The logical partner is, of course, the Rivierenland Water Board but a lady from the Frisian Water Board is also part of the team. “A wonderful addition,” says Sjef with a wink, pointing to the picture at his desk of his own Frisian wife.
Developments

Demography

The situation in the Netherlands is that we live and work in low-lying areas. Good water reporting is therefore crucial for taking timely measures and evacuation (if necessary). The same is true at the global scale, also because of the more erratic weather as a result of climate change. In addition to a very diverse development of local initiatives for information and measures, we see an overall picture in which the authorities’ centralized steering activities and information provision actually form a basis for these local initiatives. Countries that cannot afford such a central facility are increasingly assisted by international government initiatives and partnerships.

Economy

A continuous drive towards greater efficiency is also reflected in the use of water reporting. There are many commercial players in this market, nationally and internationally, that can also provide the information. However, for reasons of cost-effectiveness, the government decided in 2020 to do this itself. The importance of security and basic services was also decisive in this regard. The data is made available to create a broad market in which commercial parties can cater to specific users and for specific purposes.

Socio-cultural Developments

People want to contribute their own ideas and solutions. By involving them in the decision-making about products, they feel more trusted and valued. Faced by the urgency and scale of the climate problem, people have started to realize that the government is an important part of society. The prevailing sentiment of 2017, namely that the government is a money-consuming busybody, has practically disappeared.

Technology

The energy transition has really taken off. More than half of our energy needs is met by renewables. Both in the generation and consumption of energy, the government’s water and weather forecasts appear to have great added value. Through central information production and open distribution, this information is accessible to all. Thus, pumping stations are optimally deployed in accordance with varying wind and solar energy rates and needs. In addition to an economic effect, this also facilitates the natural buffering of energy by deliberately delaying the pumping. This is also known as ‘the blue battery’.
Ecology

By 2025, Rijkswaterstaat has made all its offices energy-neutral. Also the Water Boards expressed their strong relationship with water and commitment to water management for highly-sustainable buildings and the execution of tasks. Own initiatives for local power generation, sustainable construction and efficient use of pumping stations spread like an oil spill to other initiatives by companies and institutions (although oil has now become an outdated medium).

Politics

The very tangibly changing climate has brought about a shift in government tasks. Initially, the prevailing sentiment was that the government had done too little to prevent climate change, but now that same government is being held more or less responsible and must solve the problems itself. As the urgency is felt by all members of society (at last), there is more willingness to spend tax money on the problem, and there is even a fighting spirit (“we’re going to tackle this,” and “we’re going to keep our heads above water.”)

A continuous drive towards greater efficiency is also reflected in the use of water reporting.
## Effects

### KNOWLEDGE DEVELOPMENT

<table>
<thead>
<tr>
<th>Knowledge Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domain and local knowledge</td>
<td>Is safeguarded by Rijkswaterstaat and the Water Boards</td>
</tr>
<tr>
<td>Model development</td>
<td>Models of Rijkswaterstaat and Water Boards combined to form one set</td>
</tr>
<tr>
<td>Forecasting knowledge</td>
<td>Extension of disciplines</td>
</tr>
<tr>
<td>Decision-making process</td>
<td>Stays the same, but focuses on more disciplines</td>
</tr>
<tr>
<td>Data analytics</td>
<td>Not yet taken into account</td>
</tr>
<tr>
<td>Cross-disciplinary knowledge</td>
<td>Extension of the scope of water reporting</td>
</tr>
</tbody>
</table>

### COLLABORATION

<table>
<thead>
<tr>
<th>Collaboration Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between authorities</td>
<td>Collaboration at the top</td>
</tr>
<tr>
<td>Between market players</td>
<td>Relationship between market and knowledge institutes reviewed</td>
</tr>
<tr>
<td>Civic participation</td>
<td>Strongly taken into account</td>
</tr>
<tr>
<td>Long-term collaboration (&gt; 2 yrs)</td>
<td>Strong by opting for each other</td>
</tr>
<tr>
<td>Co-creation, CoP, Networking</td>
<td>Wider collaboration, including citizens and market</td>
</tr>
<tr>
<td>Open source</td>
<td>Release of open data, built tools open source</td>
</tr>
</tbody>
</table>

### MARKET

<table>
<thead>
<tr>
<th>Market Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>International</td>
<td>International collaboration (neighbouring/North Sea countries) stays</td>
</tr>
<tr>
<td>Private customers</td>
<td>Catered for by open data services, but are not customers</td>
</tr>
<tr>
<td>Dynamics / diversity</td>
<td>No specific attention</td>
</tr>
<tr>
<td>Consultancy</td>
<td>Growing in multiple disciplines, focus on needs</td>
</tr>
<tr>
<td>Open market</td>
<td>Little change in market approach</td>
</tr>
<tr>
<td>Forecasting as a service</td>
<td>Is not left to the market</td>
</tr>
<tr>
<td>Tools/technology as a product</td>
<td>Authorities remain major funders/buyers</td>
</tr>
</tbody>
</table>
In Conclusion

The world continues to search for a balance between public authority tasks and tasks left to the market: between national interest and commercial interest. On the one hand, this keeps all parties focused while, on the other hand, this energy could be better used to serve citizens and professionals, the public and private sectors. A clear status quo, that also remains constant for a longer period, provides the necessary conditions to get things done together. The urgency of climate change, climate adaptation and funding of government are not arguments for organizing matters differently but rather interests that need to be served.

The basic services, and the open data and advice produced, provide a lot of room to other initiatives, both in communities and in commercial applications. In this manner, information remains widely accessible and serves a large innovative, creative market. If the basic services are robust and future-proof, this will also serve the interests of that market.
In 2025, the compact government will outsource hydrological forecasting to private parties. As forecasts are key elements of the government’s core function — i.e. warning the population about hazardous situations — forecasters will have to meet strict requirements, also in relation to the protection of citizens’ privacy. This means that unrestricted use of Big Data is no longer possible.

The market’s intuitive response is to engage in competition for public contracts. Particularly small companies that do not have all the required expertise themselves will seek ways to collaborate. Those companies depend on ‘Communities of Practice’ to collect and maintain knowledge. The same small companies make much use of open source software and data.
Dutch politics in the 2010s were dominated by liberal governments. The Dutch liberal party (VVD) consistently worked towards realizing the ideals of small government. Where possible, government tasks were reduced or outsourced to the private sector. All this had been implemented through an amendment to the General Administrative Law Act. This amendment is commonly referred to as the ‘Small Government Act’. This has also had consequences for hydrological forecasting. Hydrological forecasts are no longer made by Rijkswaterstaat’s water management centre or the water boards, but by private companies. The forecasts are provided to the authorities concerned, which subsequently use these forecasts to inform their decisions. The producers must meet the authorities’ strict requirements relating to the basic materials (i.e. the data), the production process, and the forecasters. There are also a number of performance criteria that must be complied with.

In the 2010s there were virtually no limitations on data collection by hardware and software providers. The amount of data collected was huge and the term ‘Big Data’ was therefore very appropriate. The concerns about privacy soon proved justified: sometimes health insurance and loans were refused on the basis of data analysed by the providers – without taking sufficient care. In response, a lobby was organized which was strong enough to eventually enforce new privacy legislation.

On the insistence of both the coalition partners and opposition, and against the liberal party’s will, the new Small Brother Act was adopted in 2022. The law states that data remains the property of the producer – the owner of the sensor at the time the data was generated. The data may only be used for a particular application if the owner has actually given permission for use in that application. This permission may be revoked at any time. The right to use data may only be sold by the owner. Data can therefore not be resold by the buyer. Data must always be accompanied by a certificate of origin, so that the data can always be traced back to the party who generated that data.

Companies that use data generated by others are strictly controlled and certified. Certified data partners invest heavily in these procedures. The costs are passed on to the customers of their products and services. Thus quality comes at a price.

The Small Government Act should also be considered within the context of free trade between EU Member States. Contracts for tasks that were previously carried out by the government can now, in principle, also be won by non-Dutch providers. This is somewhat more complicated in actual practice – often the services need to be offered in Dutch and, if it concerns hydrological forecasts, local knowledge is necessary. Consequently, foreign providers are often excluded. It must be said, however, that they increasingly know how to meet the set requirements.
At the end of January 2025, the country looks back on a turbulent first month of the new year. On Monday, January 13, spring tide coincided with the peak of a storm surge caused by Ankie, a severe northwestern storm. This resulted in water levels at Hook of Holland being higher than those measured during the disastrous flood of 1953. This time the dikes were strong enough. Furthermore, the population had been alerted in advance and had evacuated in the weekend before the storm. There were concerns as to the state of the storm surge barriers and the government did not want to take any risks. The evacuation had a huge impact: the economic loss was considerable and it also led to casualties. The suspicion was that many people had suffered psychological traumas that would take years to heal. The evacuation also led to a political crisis. The government is doing its best to keep control of the situation. The press and the opposition parties, however, pointed the finger at the government and said the evacuation had been unnecessary as the flood did not occur.

Pieter Eisenga, however, looks back with satisfaction on the forecasts his company, The Hydro Forecaster, made. Based on these forecasts, and after consultations with the government and Rijkswaterstaat, the safety regions had decided to evacuate. The forecasts were found to be of very high quality: the final water levels were close to the best prior estimates and the confidence intervals provided were narrow. Given the intensity of the storm, that was not self-evident.

The storm was the litmus test for the new government policy on hydrological forecasting. Until the end of the 2010s, hydrological forecasts had been made by Rijkswaterstaat and the water boards. However, the ‘Small Government Act’ that had been enacted by parliament in 2020 stated that many government tasks (including hydrological forecasts) could equally well be carried out by the private sector.

As of mid 2024 the new reality is that governments purchase forecasts on the market. Market players are eligible only if they demonstrably meet the strict conditions. These conditions relate to staff training, internal procedures, data to be used, and the realized uptime. Also not unimportant, the forecasting skills must be demonstrably high.

This also applied to The Hydro Forecaster. Eisenga had established the company in 2018 when the Small Government Act was still in preparation. His approach is innovative: forecasts are made using a hybrid solution linking ‘old fashioned’ process models with modern deep learning technology. Data is derived from traditional monitoring networks and new data sources. These new data sources are selected from the overwhelming range of sensor data from mobile phones, tablets, cars, bikes, wearables, robots, web applications, and Internet of Things devices.

In 2022, however, there was a hitch when new privacy legislation was adopted. The new act imposes huge restrictions on the use of Big Data. Data may only be used if explicit permission has been granted for its use in the applications mentioned in the data agreements. Also, the data must be provided with a certificate of origin. The consequence of this legislation was that many data sources are no longer useful – at least not until agreement has been reached with the owners of the sensors. And that may take several years.

The Hydro Forecaster strictly complies with the new privacy act. Behind the scenes, new user agreements with sensor owners are being negotiated. Perhaps the events surrounding Ankie will make people more willing to share their data. Until then, the company must make use of their unique deep learning technology. It was by no means easy to get all aspects certified. The technology is poorly understood by the certifying parties,
Today, Eisenga visited Rijkswaterstaat’s water management centre in Lelystad, where he spoke with representatives of the National Flood Commission (LCO) – the primary user of his services. During the storm, there had been intensive contacts between Eisenga’s firm and the water management centre. Eisenga’s people received loads of questions day and night about the assumptions underlying their water level forecasts and the precise meaning of the uncertainty estimates. Today, this collaboration was evaluated.

This implicitly means that the new government model was also evaluated. The storm was after all a stress test for the Small Government Act.

The evaluation proceeded smoothly. As Eisenga expected, the LCO is very pleased with the services provided. Eisenga noted that some of the Rijkswaterstaat staff were in a somewhat nostalgic mood. Perhaps they had secretly hoped that a failing collaboration would lead to a return of forecasters at the water management centre. Nevertheless, they greatly admired the performance delivered. Eisenga has good hopes that his contract with Rijkswaterstaat will be extended later this year. That will also give him some time to think about new customers and new services. So far, his forecast horizon had not been more than one to two years. Perhaps it is now time to for him to forecast his own future!
Developments

Demography

After the rigorous slimming of the government, a substantial part of the working population provides for themselves by means of self-employed entrepreneurship. Self-employed entrepreneurs are often highly educated. They tend to ‘hop’ from one client to another. They have knowledge of the domain in which their client acts but not of the specific environments in which they are (temporarily) employed.

The refugee crisis of the mid-2010s caused European societies to become more pluriform. This is especially true for the prosperous Schengen countries such as Germany, France and the Benelux. These countries have now large groups of workers from former colonies, labour migrants and ex-refugees.

In the Western world, ageing is at its peak: by 2025, a record number of employees are retiring. In non-Western countries, the situation is very different. The populations of China, India, Africa, the Middle East and South America are significantly younger - and larger. Those who can afford it go to the West to study. In those countries there is a large middle class evolving that demands from their authorities that the infrastructure is in good shape. This applies to the physical and digital infrastructure and also to public services, such as the early warning of the at-risk population in case of hydro-meteorological disasters.

Economy

Smaller government has led to lower public service costs. The decrease in the number of civil servants was greater than the increased costs of hiring private sector services. The economic activity in the private sector has obviously increased. It is expected to grow further now that there are guarantees of turnover and it has become easier to invest in new customers and new products and services.

The volume of trade between EU Member States, on the one hand, and the United States and the United Kingdom, on the other hand, is more or less equal to the level of before the Brexit (ultimately effected in 2021) and the ‘America First’ policy.

There is a significant sector of ICT companies that specialize in tagging data so that data can be traced back to the source.

Socio-cultural Developments

People increasingly think structurally about their own future. This is also made possible by the huge increase in available forecasts or predictions. The non-existence of forecasts in certain domains has become almost unacceptable. One of the side effects of these developments is that people are much better able to value and effectively respond to forecasts – even if forecasts are characterized by uncertainty. At schools and universities, more emphasis is placed on uncertainty analysis and how to link it to decision-making.
New privacy legislation significantly restricts the use of Big Data.
Guarantees that the new privacy legislation has put in place is once again making it possible for citizens to share data without having to worry. Big Data will be booming again, although it will still take several years before the level of pre-privacy law will be achieved.

Big Data has become ‘ethical’. Data owners know exactly in which applications their data are used and may revoke their permission. This is indeed happening and thus a natural selection is made between applications that are acceptable and applications that are not acceptable.

Technology

Machine learning technology has really taken off. It is becoming increasingly possible to predict the behaviour of systems in advance – even for the future. For many applications, this means that high-quality forecasts can be made in ‘normal’, or non-extreme, situations. Routine forecasts are made for applications for traffic, weather, waiting times, delivery times and conversion. The demand for these has increased sharply.

Technology using or based on Big Data has become more sophisticated. It has been made suitable for the additional requirements and preconditions imposed by the new privacy legislation. Like food, data can be traced back to the source.

The increasing scarcity of clean drinking water and agricultural land (see below) has led to an increase in ‘smart’ solutions for making optimal use of available sources. In many of these solutions, forecasting plays a role (often in combination with optimization technology).

Ecology, Environment and Climate

The climate has become more extreme than in the mid-twentieth century. The infrastructure in many areas proved to be no longer robust. Natural disasters occur more often than before. Scarce resources such as clean drinking water and farmland are becoming even scarcer.

Politics and Governance

The role of the government has become different: less execution, more steering. In 2025, there is still sufficient in-house expertise for making hydrological forecasts. This expert base will continue to decline in the future.
## Effects

### KNOWLEDGE DEVELOPMENT
- **Domain and local knowledge**: Essential for the acquisition of public contracts.
- **Model development**: Long and drawn-out process; does not fit in with short-term contracts.
- **Forecasting knowledge**: Becomes concentrated in providers of forecasting as a service.
- **Decision-making process**: Knowledge of decision-making processes is purchased separately.
- **Data analytics**: Deep learning is an essential part of hybrid forecasting.
- **Cross-disciplinary knowledge**: Providers are characterized by ‘data analytics meets hydrology’.

### COLLABORATION
- **Between authorities**: Authorities do not necessarily collaborate to increase efficiency.
- **Between market players**: Sense of competition; distrust; little collaboration.
- **Civic participation**: Not or not very essential.
- **Long-term collaboration (> 2 yrs)**: Not or not very essential.
- **Co-creation, CoP, Networking**: Important source of knowledge for small enterprises.
- **Open source**: Answer to privacy concerns. Lifeline for small enterprises.

### MARKET
- **International**: Strong increase in the demand for real-time forecasting as a service.
- **Private customers**: Strong increase in the demand for real-time forecasts for use in the private sector.
- **Dynamics / diversity**: Rigid market.
- **Consultancy**: Authorities seek advice about how to outsource their processes.
- **Open market**: Open market but local knowledge is an essential award criterion.
- **Forecasting as a service**: Market consists of providers of forecasting as a service: fewer but larger customers.
- **Tools/technology as a product**: Large demand; strict tendering procedures.
In Conclusion

Dilemmas

The demand for forecasting as a service is high. These services can be provided by large or small businesses. Large companies can bring in all the necessary expertise from their own ranks, while smaller companies and individuals need to work together to provide these services. The question remains which tools the providers will use. Are these tools purchased or developed in-house?

Chances

The private and public demand for real-time forecasts worldwide is strongly increasing. However, the emphasis has shifted since 2017 from forecasting tools towards ready-made forecasts.

The availability of new technologies – often available as open source – makes it possible to make analyses that were unthinkable in 2017. Most of these technologies could not have been developed by small companies.

Paradoxically, the answer to privacy concerns can be found in open source applications. These are made sufficiently robust using a kind of ‘many eyes’ principle.

Risks

The focus of providers has shifted towards providing online services. The underlying local knowledge is given less attention - and thus less funding.

Although the government market is in principle open, much local knowledge is required. Consequently, services are usually provided by local providers. This is a situation which in fact obstructs free trade.
Start-up Society
Summary

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. Citizens and businesses are looking for services in which information is translated into impact, i.e. impact on themselves and impact on society. To meet this demand, there will be more and more transdisciplinary exchange of knowledge. Using new visualization methods, the impact can be communicated to a broad group of people. Rising unemployment will lead to higher self-reliance among citizens. Looking after each other (perhaps out of necessity) will be the rule rather than the exception.
The Path to 2025

2017 was a year of change. After the Dutch elections, a nationalist government emerged, Brexit was beginning to gain pace, and the U.S. president laid the first stone of the Mexican wall. Confidence in government was lower than ever. Even in a country like the Netherlands, which had one of the most trusted governments in the world, citizens 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 cooperatives, and telephone insurance for and by citizens. This gave enterprising citizens the feeling they had regained control over their own lives, but others felt disadvantaged by technological ‘progress’.

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 that there is less and less demand for hazard forecasts and a growing interest in impact forecasts. Thanks to the increased amount of data, reliable impact forecasts are also becoming easier to make.

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.
By 2021, the government decided to decrease public services. In recent years, it was found that there are enough suitable parties to take over public services. It is also expected that these services will become cheaper and even better. To maintain the level of economic activity, the government decided to simplify regulations. The hope is that focusing on core tasks will help restore confidence in the government. After 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 emerged as a result of the increasing unemployment rate. Courses with slogans such as ‘How to do business’, ‘The advantages of interdisciplinary work’ and ‘Programming can be learned’ are very popular. Most of the job vacancies are for ICT practitioners, communication staff and people who can translate technology into practice. This is also evident in hydrology. 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.

Communication tools such as flashy infographics, augmented reality apps and interactive films are popular. But the ultimate magic word is IMPACT. Start-ups that respond to this trend grow rapidly and are successful in the 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.
Margareth Garcia-Suarez has just left the building of the Delft incubator where her start-up ‘Drought Impact Visualizer’ has been located since a few weeks. Incubators from different countries wanted to have her and tried to lure her with all kinds of interesting offers such as a free workplace, coaching and access to capital. Eventually she chose the Netherlands because of the dynamic start-up climate and the fact that there are not too many rules here. Being a 35-year-old daughter of two Spaniards raised in England, she also liked the international and open character of the Netherlands, which she thinks is a good basis for building her start-up.

“Now things are really taking off,” she thinks. She has collected enough money through crowd funding to make a good start, but now she has to make her plans come true. An African NGO, an agricultural cooperative in Spain, and a group of floating home owners in the Netherlands are interested in her drought forecasts and, more particularly, in the impact to their specific area, so that they can determine if drought measures are necessary. As they have nothing to expect from the government, they decided to take the bull by the horns themselves. Margareth is pleased that so many different parties have an interest in her start-up. However, she has not set up her start-up to answer specific questions but primarily to visualize the impact of drought on vulnerable groups.

Based on open street maps, a large amount of data sources and semantic algorithms, she is able to create interactive maps that can be consulted throughout the world. Using these real-time impact forecasts, farmers can immediately see if a drought is pending, how a drought will affect their harvests, what the resulting economic loss will be for them, and whether
they should take measures, whilst, for example, governments may receive a warning message when their drinking water supplies are under threat. She has one more problem to solve. Snapchat Earth Viewer has just launched an application in which she can see real-time where which groups live and how they migrate. This would make her work much easier, but it will also make her dependent on that large multinational. But this could result in a substantial loss of customers, because her potential customers are disappointed in Snapchat, and also in expensive and logical knowledge institutes, and have been therefore been looking for an independent small business with the same kind of services. * Pling * She wakes up out of her reverie and looks at her phone. It says the expected Independent coins from Tanzania have been credited to her account. She had sent a voice message to this party half an hour ago, asking if they could transfer the money. The quick response was probably due to her coercing tone.

It is already dark when she goes home. She has been here only two weeks, so she does not yet know her way around. Is she going to walk or take a mobike or gruber (the sustainable self-propelled version of an uber)? She knows that there is a neighbourhood watch in the neighbourhood to the west side of the incubator. The neighbourhood on the east side, however, does not have such a local security service. She asks her phone “Is it safe in this street?” The phone answers with a map of the area coloured in green. Then she asks “Is there a mobike nearby?” The nearest mobike is almost a mile away. She has no other choice but to walk home.

When she arrives home, dinner is ready. Her roommate Jorien has prepared an elaborate Indonesian pilaf. Jorien’s flexible contract with the Dutch government has just been terminated. She used to work as a purchaser of dredging services. After a second reorganization, she was made redundant. The port of Rotterdam now purchases these dredging services from two social companies. One company collects information from sensors on ships to determine how much dredging needs to be done at which location(s). The final advice is not only based on the benefits for shipping, but also on options that create as little negative impact on nature as possible. Based on this information, the other company navigates their remotely controlled dredging vessel to the indicated locations. The vessel has a crew of people all aged over 50 who have difficulty finding new jobs due to the high unemployment rate. It is a great solution, but not for Jorien who has lost her umpteenth job. Margareth feels for her, but cannot really help her. Many of her friends have become unemployed due to cuts and robotization over the past few years. Some of them have become self-employed entrepreneurs or are employed by small initiatives, while others are looking for more stability. In response to the ever-increasing group of unemployed young people, many companies switched to a 32-hour working week, so that they make use of a greater part of the pool of talents. This scheme also offers Jorien a chance to get back to work.

After dinner Margareth gives the command ‘project news’. After a brief second, the beautiful smile of news reader Sasha Duel appears on the screen on the wall of the living room. The most important news item is about Sustainable Development Goals. Following a period of time in which the realization of these goals seemed farther away than ever, most goals have now been achieved. Particularly multinationals invested a lot. NGOs and small businesses did much of the field work. After having watched some other pre-selected news items, she briefly sends a short video message to her parents, and then goes to bed.
Developments

Demography

Urban growth and a self-reliant countryside
The density of cities is increasing. This facilitates the exchange of ideas and ensures that various services and amenities, such as a bakery or a hospital, are nearby. On the other hand, there are also people whose quality of life is negatively affected by the hustle and bustle of city life and therefore ‘flee’ to the countryside. Many people have work that can be done almost anywhere, but the services in rural areas have been significantly reduced. Children are increasingly taught online and are cared for by care robots. Hydrological forecasting systems are therefore mainly developed for the urban areas, where the majority of the customers requiring information live.

Immigration figures remain high for the Netherlands. Social class differences continue to exist but are less pronounced compared to situation at the end of the 2010s. Some of the elderly may feel disadvantaged as a result of technological progress, but many others have become much more independent and still participate in society.

Economy

From linear to circular
The banking sector has a lot less power than in 2017. Most banking services have been taken over by independent initiatives such as blockchains, of which the independent coin is an example, but also by multinationals who have set up payment services themselves. A large group of citizens have abandoned linear economic thinking, as more economic growth each year no longer seems realistic, and opted for circular thinking instead. In the circular economy, citizens, governments, companies and numerous small initiatives collaborate to close material circuits, mostly using new technology in the field of bio-based construction. There are also more and more social enterprises, organizations in which social mission carries more weight than profit. In line with this, the welfare indicator (WI) was introduced, a new measure of a country’s economic situation. The WI has replaced the GDP, which was not appropriate anymore.
Socio-cultural Developments

Dynamics, uncertainty and looking after each other
Socially and culturally, the world can be compared to a pan of soup bubbling on a gas ring. Traditional, dynamic, but also full of turmoil and uncertainty. Social facilities are being eroded worldwide, which causes many people to fall back on their own social network. The advantage of the latter is that citizens increasingly look after each other. Those who used to be fanatic PVV voters are now collaborating with immigrants to form security cooperatives. Ongoing liberalisation of the labour market, education and healthcare creates uncertainty. A large group of people wonder who will take care of them. Highly educated city dwellers benefit from the dynamic climate. Generally speaking, less importance is attached to financial resources. Money stands for injustice and corruption. Teachers now have the status that bankers once used to have.

Technology

Drones, augmented reality and semantic net
Technology is advancing rapidly, strongly driven by start-ups operating in an international network. New technology is not only used by companies but also by citizens. Local residents purchase drones to maintain safety in their neighbourhoods. Augmented reality is being used for all kinds of things, for example, to have a look at a sofa one is thinking of buying or to check whether a company location will be flooded in the event of a dike breakthrough. Multinationals launch around five satellites a day into space. The data obtained is mainly used for marketing purposes and for enhancing the semantic web. Data is power. The expectation is that everyone will be able to launch their own satellite in a few years.
In the start-up society, citizens and companies will steer us towards a sustainable society, with minimal influence by government.
For governments, the situation is changing rapidly. They mainly focus on problems with data quality assurance. For example, are weather forecasts still be reliable? Most citizens do not seem to worry about this. Among the multitude of sources there is always one they can trust.

Ecology

Natural capital and ecosystem-based adaptation
Biodiversity is high on the social agenda. After a period of decline in biodiversity due to increased urbanization and climate change, multinationals and citizens take action to restore and/or protect increasingly scarce nature. After all, nature provides services to people, such as recreation and protection against floods. The inclusion of natural capital on the company balance is the first concrete action taken by companies.

The effects of climate change are becoming increasingly noticeable. After 2017, no mitigation efforts were made because governments did not take action. Citizens and businesses were insufficiently aware of the need to take action, but nowadays this awareness is widespread as a result of the many conflicts caused by climate change. Climate change mitigation is slowly producing results, but rapid action in the area of climate change is inevitable. Ecosystem-based adaptation is implemented all over the world, made possible by green bonds. Hydrological forecasting systems play an important role in this. They are used to better estimate where and when ecosystem-based adaptation is best applied.

Politics

Populism partly eradicated; increasing number of claims against and by the government
After a long time of populism, the situation has normalized. The government is smaller and regulations have been simplified. The retreating state has led to nostalgia for the welfare state. To the surprise of populists, traditional left-wing parties have become popular again. They have, however, much competition from new parties that want to give the citizens more power through referenda, live voting (in VR!) on legislative proposals, and other forms of participation. By 2025, the number of claims against the government by companies and vice versa is higher than ever. The most mentioned topics concern the protection of citizens’ privacy and the quality of services provided.
### Effects

#### KNOWLEDGE DEVELOPMENT

<table>
<thead>
<tr>
<th>Domain and local knowledge</th>
<th>Less demand for local knowledge as a result of big data</th>
</tr>
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<tr>
<td>Model development</td>
<td>More direct data interpretation than model development</td>
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<tr>
<td>Forecasting knowledge</td>
<td>Statistic and forecasting knowledge remain essential</td>
</tr>
<tr>
<td>Decision-making process</td>
<td>Particularly geared towards local and sectoral decision-making processes</td>
</tr>
<tr>
<td>Data analytics</td>
<td>Data analysis is at the heart of progress</td>
</tr>
<tr>
<td>Cross-disciplinary knowledge</td>
<td>Knowledge from many disciplines is required to estimate impact</td>
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#### COLLABORATION

<table>
<thead>
<tr>
<th>Between authorities</th>
<th>Authorities play a modest role</th>
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<tbody>
<tr>
<td>Between market players</td>
<td>Particularly short-term collaboration between start-ups</td>
</tr>
<tr>
<td>Civic participation</td>
<td>Citizens demand participation in developments</td>
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<td>Long-term collaboration (&gt; 2 yrs)</td>
<td>Fewer and fewer long-term collaborations as a result of dynamic world</td>
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<tr>
<td>Co-creation, CoP, Networking</td>
<td>Innovations mainly developed through co-creation and use of networks</td>
</tr>
<tr>
<td>Open source</td>
<td>Open source data and software are prerequisites for innovation</td>
</tr>
</tbody>
</table>

#### MARKET

| International               | Core of the market activity shifts to the developing world; international collaboration is crucial |
| Private customers           | Government plays a less significant role; questions from private parties are dominant |
| Dynamics / diversity        | Market is dynamic with great diversity in users and providers |
| Consultancy                 | Consultancy sector in decline; mainly demand for services. Start-ups do consultancy on the side |
| Open market                 | Little regulation and steering by the government |
| Forecasting as a service    | Large number of service providers; ample choice for users |
| Tools/technology as a product | Individual tools are practically not sold anymore |
In Conclusion

The start-up society is apparently an attractive scenario for many people. The key words are change, progress and innovation. The scenario shows an unbridled belief in technology, and consequently there is little room for technological failures and technology-related privacy issues, which could nevertheless play an important role.

A prerequisite for a flourishing start-up society is the free movement of people and services. Increasing nationalism could lead to a situation in which this prerequisite cannot be met. Economically, this could make the start-up society much less successful than expected.

Hands-off government may restore the citizens’ trust in government in the long term, but in the short term it could also lead to protests and dissatisfaction among citizens. Without a caring government, the division in society could grow. Many social safety nets have been removed or are no longer available to all. This can lead to a class society with all associated forms of dissatisfaction.

In the start-up society, citizens and companies slowly lead us to a sustainable world, while there is hardly any steering from government. When government scales down its involvement, intrinsic conviction of the importance of sustainable development will have to ensure that the path of sustainability is taken. It cannot be ruled out, however, that developments go in an entirely different direction.

The focus on impact leads to more opportunities for social scientists in the labour market. A mix of technical and social scientists can also lead to exploration of whole new services in hydrological forecasting and other systems.

The scenario shows that there will be changes in the market for hydrological forecasting systems. Civil cooperatives and multinationals will be the main users in a market that is initially still dominated by government. The type of competitors also changes. Many more start-ups and also large companies will offer forecasting systems not hampered by lack of hydrological knowledge. The challenge is to acquire a position in this new dynamic market.
Google Forecasts
Summary

The world in 2025 will have become much more open. Globalization will be back. China and Russia will have joined the open data and open source movement, and – after the protectionist years of the last decade – the US and the EU will also fully participate again. New small and smart sensors will provide data on all aspects of hydrology. Big data will have become bigger. Global companies such as Google will make global hydrological predictions based on high-resolution hydrological models. Research at local universities and research institutes around the world will help to improve these predictions. Government agencies such as Rijkswaterstaat will therefore have stopped delivering hydrological predictions. In a more urban but also international world, many small and innovative businesses and citizens’ initiatives will combine these predictions with Big Data, and will provide a multitude of technical products and services aiming at satisfying local information needs.
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.

This led to a shift in the world order. Previously, the United States and the EU
had been the advocates of openness and transparency. In the years 2017-
2020, however, China had gradually taken over this role and evolved into the
great advocate of openly sharing information. Even Russia could not stay
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
integrity among politicians is considered to have been the incentive for
the growing populism of that era. As a consequence, people’s trust in the
government as the defender of their interests had been dented. 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
that information provided. Openness and transparency eroded the distrust
and gave citizens the opportunity to develop initiatives that also served their
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
available. Smart businesses and citizens’ initiatives flourished and
developed innovative technologies to make information available locally.
Nowhere else was this as clear as in the city. By 2025, 70% of the world’s
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.

These developments and investments in technology had major
consequences for hydrological forecasting. The investments in research
and technology, the development of new and smart sensors and the
launch of new and innovative satellite measurement technology had
a positive impact on society. The entire hydrological cycle was now
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
at the end of one’s garden was available. Of course, the data contained
uncertainties, but these could be made visible using new communication
technologies. As so often, meteorologists were already one step ahead.
By 2020, they already had very high resolution global models available –
available to everyone. This technology was also soon applied in hydrology.
High-resolution global hydrological forecasts had become a reality,
and are now being offered by companies such as Google. Google Global
Forecasting System. Technologies like Google Earth Engine had helped
enable research groups at local universities and knowledge institutes to
contribute to these global developments. The same technologies also
gave citizens and local initiatives access to those scientific advances that
Google is using. But also relevant hydrological information collected by citizens with smartphones and smart devices is being fed back to Google, to make global forecasts even better. A truly participatory process. The social relevance and value of research has become very clear. Transparent and available to everyone, and everyone could contribute.

The accessibility of global information gives confidence, and so does the fact that the state of the art is always at one’s fingertips, and the fact that citizens have the opportunity to invest in improving information that serves their own interests. More so than the hydrological forecasts previously made by government agencies such as Rijkswaterstaat. The trust in public services was further dented by the floods at the end of January 2019. Government agencies that did not collaborate properly. Politicians who initially wanted to save their own skin. The non-disclosure of important information. The 2017 fictional television series “Als de dijken breken” (“When the Levees Break”) seemed more a documentary of a true event - except that it had been recorded well before the actual flood. Like many other hydrological agencies, Rijkswaterstaat 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.

By 2025, 70% of the world’s population lived in cities, and the need for information and forecasts specifically aimed at the city and its citizens was the most urgent.
Situation in 2025
An article in a science supplement of an online newspaper

Global forecasts with local relevance.
“Wow, that’s cool!” Jacqueline says it initially even scared her a bit. She had been tinkering for a while to get it all going, and at first it did not work. But now it did. She put the 3D glasses on, and walked along with the forecast flood. Past Borgharen and Maastricht, through the floodplains, back to the main channel, past the locks at Itteren, towards Rotterdam and, finally, the sea. Travelling along with the water like a fish. A fish of the near future, telling the story of the flood wave that was caused by the heavy rainfall in the Ardennes of the past few days. A fish that can see where the water is, and at what time it arrives in cities and at critical infrastructure along the River Meuse (Maas), such as locks and bridges.

On these rainy days, Jacqueline Kusters, founder of Natural-Hazards: Virtually, is focusing on showing how a flood wave travels through the river landscape. She builds on the hydrological forecasts made available by Google, cleverly combining them with global and local data sets. On dry days, she uses the same expertise to look at other natural phenomena. She founded the company together with her friends and colleagues, Jason Sparks and Hamid Zafra. The three had never met each other in person, and only know each other through Google HoloConnect. As we are looking at the pictures that tell the story of the upcoming flood in the River Meuse, the hologram of Jason appears. He congratulates Jacqueline on getting the system running. Physically, he is in New Zealand, but it feels as if he is sitting at the table with us. He can use the images again for the Waikato River in Hamilton, his home town, where now a new day is dawning. Hamid is still sleeping. In Dubai it is night.

“Wow, that's cool!”
Jacqueline says it initially even scared her a bit.
Natural Hazards: Virtually is a typical example of the type of business and citizen initiative that have emerged in recent years as a result of the unprecedented opportunities that the open data revolution offers. Jacqueline not only shows the story of these floods but is also a stakeholder. As we talk, I feel how her houseboat is slowly rising. The flood wave is coming. She has also sent the images to her neighbors via Gwitter. This is typical of these small businesses. As technologies and data have become so accessible, it is easy for everyone to come up with smart things that can have added value to the local community. However, you do need some expertise in handling large amounts of data and visualization technology. But in 2025, every community has a digital nerd who can do the job for them. These small companies are usually non-profit companies, or have adopted a local version of the revenue model that companies like Google and Facebook use. Relevant information about the upcoming flood is shown. But you also know right away that you can get a healthy five-grain bread, and perhaps a slightly less healthy, but very tasty Limburg pie at Maurice’s Bakery, at number 36 in the Voerendaalseweg, which is three streets up, so outside flood hazard zone.

Much has changed since the Chinese have also made their data available to the public domain. Initially, they had done that in response to the increasing protectionism that emerged in the United States and in Europe during the brief presidency of Donald Trump. But now the whole world community has embraced the idea. Society wanted to change. The fierce hurricanes in the South East of the United States and the persistent drought in California definitively put a stop to all comments from climate sceptics. Large investments in satellite data provision and new and smart sensors, and the close cooperation between science and companies like Google, have advanced the technology of hydrological forecasting. What took a lot effort at the river basin scale ten years ago is now possible at the global level.

This is acknowledged by Professor Prognosis, holder of the interfaculty chair of hydrological forecasting of the cooperating Dutch universities. “In fact, this movement began much earlier,” he recalls. “We already saw it in meteorology in the early 2010s. The global computing centres, such as ECMWF in Reading in England, began to calculate with such high resolution and accuracy that the regional models used at, for example, KNMI became superfluous.” He glances at the fairly new picture on the wall, depicting a satellite with bright solar panels. “Developing and opening up new satellite data, which allows us to measure flow rates, water levels, and even groundwater levels with centimetre accuracy, throughout the world, was a milestone. The launches of Sentinel 8 by ESA and Sjinzen 6 by the Chinese were great leaps. But also the global models – to which our research group contributed significantly – the emergence of cloud computing, and the collaboration with Google were very important,” he continues. “All this made river forecasts such as those made by regional and national governments superfluous. Google can do it better, and definitely cheaper.” The role of the government in making forecasts has therefore changed considerably since the beginning of the century. At the time, hydrological forecasting was a government task. Quality assurance and the control over information relating to the safety of citizens were highly important. “We have some concerns about that now,” counters Jan Dijkzeul, Policy Officer of the Ministry of Infrastructure & Environment. “As government we knew what was needed to make good forecasts that focused on the information needs of the citizens of this country. Google cannot know that. And what if Google decides to do something else in five years’ time?”

Professor Prognosis brushes aside these concerns. “If Google opts out, we will work with the Chinese Alibaba platform. They are making forecasts too.” “That’s exactly where the opportunities are,” he says enthusiastically. “Together with our global community of scientists.
at universities and research institutes, we are working on smarter and
evener faster technologies to enable us to make the best possible use of
this unimaginably large supply of information. We call that Big Data.
Of course, we do that from a hydrological perspective. We remain
hydrologists with our two feet firmly on the ground, or... in the water.”
“Fortunately, there are still a lot of scientific issues we can sink our teeth
into. For example, how can we meet that complex information need of
an increasingly urbanised society? Urban Forecasting is the direction in
which we need to go. But it should be by the inhabitants of the city, for
the inhabitants of the city. Actually, we are now working on what we
thought was quite utopian years ago. Community-based forecasting, but
with the latest hydrological forecasting technology. Globally progressive
but locally relevant.” He even has a word for it: Glocal.

Small companies and citizens’ initiatives such as Natural-Hazards:
Virtually have responded cleverly to the need to make global information
available to citizens at the local level. Although it is sometimes quite
technical, it is visually very appealing. Jacqueline is closely watching her
screens again. Somewhere far away in the world, one of the Google Servers
has just spat out the results of a new hydrological forecast, which are
already flashing over Jacqueline’s screens. Deep in thought she peers out
of the window behind her screens and sees the water is rising. “Look, the
water’s rising,” she exclaims. “Google is right!”

Urban Forecasting is the
direction in which we need to
go. But it should be by the
inhabitants of the city, for the
inhabitants of the city.
Developments

Demography

In 2025 we saw the beginning of the peak in the number of baby boomers retiring. It is expected that the population pyramid of the Netherlands will not become more uniform until 2045 (source: Netherlands Statistics). There is, however, a relatively large number of people in the 20-35 age bracket.

At the global level, the percentage of populations in an urban area with more than 90,000 inhabitants was already 70% in 2025. In the Netherlands, that percentage was 90% in 2015 (source UNDP), and remained fairly constant. As in many other countries in the Western world, things are getting increasingly concentrated. Large cities are getting larger, small cities are getting smaller. People in cities also live in smaller flats and houses. Throughout the world we see a strong rising middle class, and inequality has decreased. Everywhere in the world large cities have become even more multi-cultural.

Economy

The global economy is growing slightly again. Particularly in knowledge intensive countries, including the Netherlands, there is moderate to good economic growth as a result of strong growth in the knowledge and service sectors. Economic activity is largely characterized by a variety of small, dynamic companies that take advantage of every opportunity, but also by non-profit citizens' initiatives.

Technocratization has led to a stronger division of labour in the labour market. There are plenty of job opportunities for people with IT skills, there is even a shortage of workers. People who are less IT skilled, including the large group of people who are about to retire, risk being excluded. This group must take a lot of initiative to stay economically active. The accessibility of technology offers opportunities, but they need to actively look for these opportunities themselves.

Socio-cultural Developments

Self-reliance and local identity are important aspects in society. However, the ease of travel and communication, together with the falling away of language barriers thanks to translation chips, means that society has locally become more heterogeneous, and globally more homogenous. As a consequence, there is more respect for diversity and people generally have little difficulty in living and working in an international environment. It should be noted, however, that this applies mainly to economically active areas. Rural areas and cities that are (just) outside this global network risk becoming socio-economically isolated.

Many people are following training programmes. There are fewer classical three- or four-year courses, and the emphasis is on self-study and online courses. The rise of these so-called MOOCs enable many people to take specific courses at their own initiative, for example, to learn technical skills, but this also means that education is fragmented and that people are less broadly educated. There are fewer highly educated people, but more people who have been trained for a specific skill.
Due to the development of nano-sensors, the availability of hydrological data has increased tremendously.
Technology

As a result of the development of nano-sensors, large amounts of hydrology-related data are available. These sensors are found in satellites, terrestrial measuring instruments, and are also used in drones to collect data as needed. Data gathered globally by government, research institutes and citizens’ initiatives is accessible to everyone through the very powerful hypernet, the successor to the internet. Open data is the core concept, regulated by the UN resolution which was tabled by China in 2020 and adopted unanimously by the UN and the Security Council.

This has led to a breeding ground for innovation. Small IT companies and citizens’ initiatives have taken the opportunity to work with this data. All kinds of technological products that unlock and visualize data are being made available and tested. The added value of these products is sometimes unclear, which means that many products have a short life span. Global players also use this data (e.g. Google Global Hydrological Forecasting Service launched in 2019).

Ecology

Due to climate change, the global climate has become even more fickle. Extreme dry periods are often alternated with extreme floods. Due to severely reduced snowfall in the Alps, the Rhine has become a purely rain-fed river. This was already the case for the River Meuse (Maas), but because of the warmer climate, the Belgian High Fens lost their role as a hydrological sponge and no longer temper the extremes. This has increased the importance and awareness of hydrological forecasts for both dry and wet periods. Strong urbanization has also led to a situation in which the consequences of extremes are becoming more serious.

Politics – Legal System

The role of the government has been greatly reduced, and strong decentralization has taken place. The emergence of large cities means that more things are now being arranged at the city scale than at the national scale. As a result of globalization, the concept of national scale has also lost significance. As a result of citizens’ initiatives, many things are also arranged at the neighbourhood and city district level. Taxes are now collected at the local level, and all tax rules under the recently adopted Global Tax Equality Treaty (GTET) have largely been harmonized. The role of the government is now characterized by a strong focus on redistribution, supported by the Global Ecosystem Services & Solidarity Act. In practice, this particularly benefits the natural areas highly valued by city dwellers. Solidarity with cities that did not take advantage of the digital revolution and with the less attractive rural areas is a constant bone of political contention.
### Effects

#### KNOWLEDGE DEVELOPMENT

| Domain and local knowledge | Domain knowledge at global level; local knowledge from local initiatives |
| Model development          | Science at global scale. No longer ‘one hydrologist, one model’. |
| Forecasting knowledge      | Emphasis on technology, model or product. Goal to deliver a forecast product is of secondary importance. |
| Decision-making process    | Technical focus. Decision made not because of necessity, but rather as an opportunity. |
| Data analytics             | Big, Bigger, Biggest Data. Maximum use of data. |
| Cross-disciplinary knowledge | Breeding ground for ideas. Eagerness and room for interactivity |

#### COLLABORATION

| Between authorities    | Minor and fragmented role of authorities. |
| Between market players | Spontaneous and short-term collaborations. Dependency on global players. |
| Civic participation    | Self-reliance and citizens’ initiatives largely replace tasks of the government. |
| Long-term collaboration (> 2 yrs) | Opportunism prevails. High dynamics and changing contacts. |
| Co-creation, CoP, Networking | Citizens’ initiatives serve local interests, but products mainly technical. |
| Open source            | Open data and open source both doctrine and ubiquitous |

#### MARKET

| International | World strongly globalized. Dynamic collaboration at a global scale. |
| Private customers | Private parties dominate the market; government no longer buyer |
| Dynamics / diversity | Brief and dynamic collaborations of various small companies & initiatives |
| Consultancy | Activity focused on the supply of technical products, also quick response to queries. |
| Open market | Equal opportunities for everyone |
| Forecasting as a service | No long-term services. Supply of product and then to next |
| Tools/technology as a product | Tailor-made technical solutions take precedence |
In Conclusion

The Google Forecasts scenario portrays a picture of a very open world, where data, information and technical innovations are openly shared. This is a very attractive picture from the perspective of an opportunistic and globalized world. There are some aspects of that world that deserve attention.

- The strong focus on globalization and collaboration is based on the assumption that people are willing to accept the open paradigm. Commercial interests, privacy considerations and narrow-mindedness can strongly inhibit that willingness. Copyright will be an issue of discussion.
- Due to the changing role of the government as provider of hydrological forecasts, it is unclear who bears responsibility for the safety and security of the citizens. Global companies such as Google will not assume this responsibility. But can we assume that this will be taken up by citizen initiatives? There is a risk of fragmentation.
- A focus on IT and technology can lead to a division in society. Due to a weak government, people need to have confidence in the solidarity of citizens’ initiatives. Parochial thinking can lead to social unrest.

But the scenario also offers a wealth of opportunities.

- There will be many opportunities for innovation, particularly by collaborating with global players. Research on hydrological processes and model developments by research groups and institutions collaborating at global level will have added value, particularly because the global dimension will cause them to work together on the same concept, and no longer on their own model.
- There will be much activity in the development of smart measuring technology and its integration in hydrological models and forecasts. Interesting innovations may emerge, such as measuring using drones.
- Big Data and the unlocking thereof will provide much space for innovation in data-analytics technology, artificial intelligence, innovation in hybrid data-model combinations, and also new and innovative ways to look at hydrology. There will be many parties that will be willing to engage in collaborations and that are also actively looking to establish collaborations.
Summary of the Effects
Summary of the Effects

The effects on the themes Knowledge, Collaboration and Market for each scenario have been charted. When the effects of the five scenarios are brought together, the following picture emerges:

Striking is that the total picture favours both knowledge development and the hydrology market.

With regard to the theme Collaboration the viewpoint “government steering” has a negative effect and the viewpoint “user orientation” a positive effect.
## Participants of the brainstorming session

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
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<tbody>
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