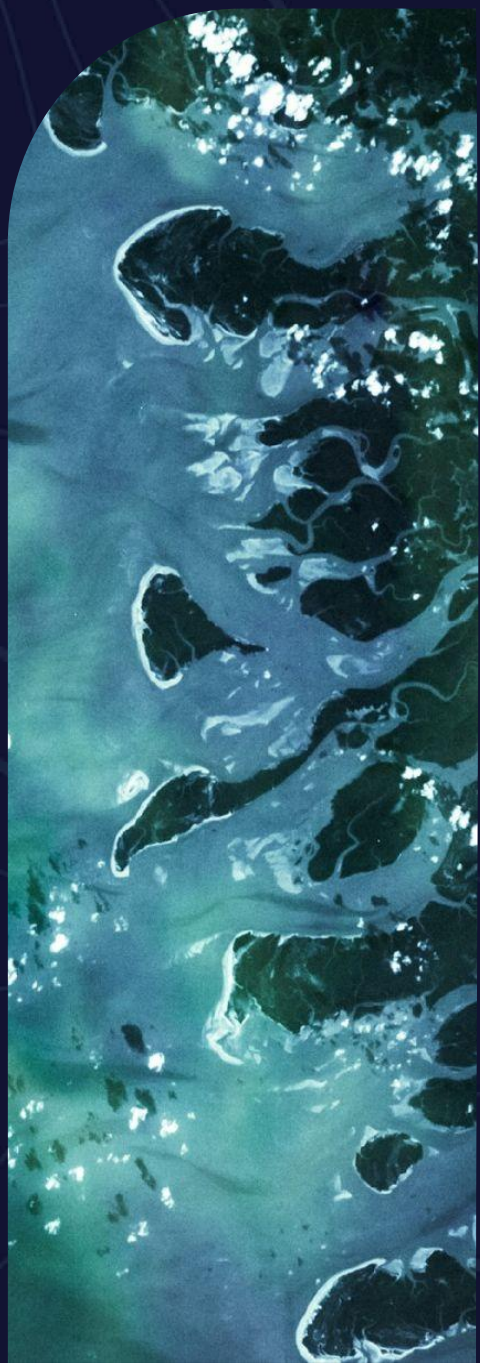
JCAR ATRACE

Climate change and Flood Risk Management in the Benelux Countries and Germany

JCAR ATRACE, 15 May 2026



Colofon

Client	Competent authorities Benelux Countries and Germany
Contact person	
References	
Keywords	Climate change scenarios, flood risk management measures, flood risk maps

Document data

Version	**1.0**
Date	15 May 2026
Document ID	[document ID]
Pages	22
Classification	Open
Status	Final version This document is a draft and for discussion purposes only. Neither the client nor third parties can derive any rights from the contents of this report.

Author(s)

This table is used to check the correct execution of the assignment by Deltares. Any other customer use or external distribution is not permitted.

Version	Author	Check	Approved
1.0	J.Aerts	F.Sperna Weiland	K.Slager

Summary

On February 18 and 19, 2026, we discussed the use of climate change information in flood risk management practice in Belgium, the Netherlands, Luxembourg and Germany during an international workshop. The event was organised under the umbrella of the JCAR ATRACE programme, and is supported by competent national authorities of North-Rhine Westphalia, the Netherlands, The Benelux Union and the Deutsche Hydrologische Gesellschaft (DHG). More than 70 experts from the different countries came together in Aachen to learn from each other's approaches and jointly identify steps forward.

The workshop was opened by Minister Oliver Krischer (Minister for the Environment, Nature Protection and Transport of the State of North Rhine-Westphalia). The Minister talked about ways to enhance cooperation across river basins and promote the sharing of knowledge and practices on using climate information in FRM.

On the first day of the workshop, participants got an overview of the current practices on the use of the climate change information by flood risk managers in NW Europe. Many of these FRM practices have also been summarized by the JCAR ATRACE consortium partners in a new scientific article in the Journal of Flood Risk Management. This paper describes the existing practices in the various countries and regions in NW Europe (Macdonald et al. 2026).

All of the FRM practitioners have a very clear message: future climate scenarios should be simple so that the general public and FRM policy makers understand them. While scientists emphasise structural and GCM-driven uncertainty, practice demands simple, actionable recommendations.

A good substantive basis for the discussion was the contribution by Flanders. They showed how to combine flood risk mapping both for current and, most notably, future climate with potential impacts to communities and properties and how these can be translated into effective spatial planning policies for reducing flood risk.

While there are large differences across the regions in how they use climate data in their FRM practices, all participants agreed that more cross-border cooperation is required to enhance standardization of methods and data.

Science can assist FRM policy with a number of activities, such as:

1. Help to setup stress testing studies to evaluate current and future FRM measures.

2. Evaluate climate communication strategies to assess the effectiveness of the use of climate scenario data into practical FRM activities; e.g. mapping, planning, and design.

3. Compare and assess the use of climate scenarios across borders and to quantify (future) upstream-downstream effects of measures under future scenarios.

4. Conduct studies on the combined effect of different FRM measures (e.g. protection, prevention, NBS, insurance, etc.) to evaluate how to best mitigate future flood risk.

5. Assess the effects of flood – or climate policy labels (Flanders), to enhance resilience of local communities. Here research is needed on the role of spatial planning within flood risk management.

Table of Contents

1 Preface

The introduction of the international workshop has been provided by **Minister Oliver Krischer,** Minister of Environment of the German State of Nord Rhein Westfalen (NRW).

His key statements were:

1. "The rapid and drastic changes in the climate currently present all of humanity with the same challenge: to remain capable of acting and to 'get ahead of the situation' in the face of a potentially catastrophic development. In close collaboration with scientific expertise, political leaders at all levels have also set about implementing adaptation measures to climate change".

2. "Events like this one give me hope. Our gathering here demonstrates that the European ideal is alive and well. Here, a wealth of expertise, a vast amount of practical experience, and a high degree of political responsibility come together in an impressive way. Let us seize this opportunity by learning from one another!"

In German:

1."Die schnelle und heftige Veränderung des Klimas stellt derzeit die gesamte Menschheit vor die gleiche Aufgabe - nämlich im Angesicht einer möglicherweise katastrophalen Entwicklung handlungsfähig zu bleiben und "vor die Lage zu kommen". In engem Schulterschluss mit der wissenschaftlichen Expertise haben sich auch die politisch Verantwortlichen auf allen Ebenen daran gemacht, die Anpassung an den Klimawandel zu vollziehen."

2."Veranstaltungen wie diese stimmen mich zuversichtlich. Unsere Begegnung hier an diesem Ort zeigt, dass der europäische Gedanke lebt. Auf eindrucksvolle Weise kommen hier gebündeltes Fachwissen, ein großer Schatz an praktischer Erfahrung und ein hohes Maß an politischer Verantwortung zusammen. Nutzen wir diese Chance indem wir voneinander lernen!"

2 Introduction

The approach for integrating climate change information into flood risk management (FRM) in Northwestern Europe differs significantly across regions. This was concluded by the JCAR ATRACE partners based on a comparison study of 20 different regions in Germany, the Netherlands, Belgium, and Luxembourg, mostly comprising the international river basins of the rivers Rhine and Meuse, and parts of the Elbe and Danube basins.

We do not consider this remarkable since generally accepted guidelines to incorporate (future) climate change are not (yet) available. With our comparative research we hope to contribute to a discussion about the use of climate information in FRM practice, where different authorities can learn from different approaches across borders and engage in cross-border collaboration.

General IPCC projections
While the IPCC projections have uncertainties, precipitation scenarios for Europe in the 6th assessment report of the IPCC are considered quite consistent in their direction[1]. Historical trends have a seasonal and regional pattern consistent with projected increase of precipitation in winter in Northern Europe. A precipitation decrease is projected in summer in the Mediterranean extending to northward regions. Extreme precipitation and pluvial flooding are projected to increase at global warming levels exceeding 1.5°C in all regions except the Mediterranean (high confidence). While the climate-change signal is rather consistent for pluvial and flash flooding, expected changes in river flooding are more nuanced across our study area. Germany is a transition zone between Northwestern Europe (where observed and projected flood peaks show mostly upward trends) and Eastern Europe (where observations and projections show rather downward trends). This latter trend is mainly due to changes in the role of snow cover and snowmelt.

[1] https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Europe.pdf

3 How is climate information used by flood managers?

Participants of the workshop got an overview of the current practices on the use of the climate change information by flood risk managers in NW Europe. These FRM practices have been summarized in a new JCAR article in the Journal of Flood Risk Management. This paper describes the existing practices in the various countries and regions in NW Europe (Macdonald et al. 2026).

The presentations and discussions afterwards gave insights that some regions have developed quite advanced future climate scenarios to assess flood management policies, whereas others mainly rely on historical information. Here we shortly describe key features of existing use of climate information in flood risk management in four regions of interest.

3.1 Flanders

Flanders (Belgium) officially published flood hazard and risk maps that explicitly account for future climate change and depict potential future flood-prone areas for all their regions. These maps have implications for urban development and spatial planning. For example, in flood risk areas, there is a requirement of climate-proof construction: Buildings are increasingly designed and constructed to be climate-resilient. This also requires architects and spatial planners to work more closely with environmental and climate objectives.

The national water agency (VMM) acts as a public service provider by openly sharing flood risk information with citizens and property owners, even under uncertainty, which builds trust and confidence. Flanders follows an open communication to the public and stimulates developing a risk culture. Flood risk data is available via www.waterinfo.be. This website provides a low probability, high-impact map for the current climate. A key aspect of the communication strategy is to simplify information and enhance public awareness. High-impact climate scenarios are provided along with a straightforward application of impact modelling into flood hazard and risk maps. These maps are used to guide spatial planning and land use management (by law regulated).

It appears that the provided flood hazard maps have proven to be accurate and trustworthy to be implemented. The experience of Flanders remarkably demonstrates that flood hazard and risk information is widely accepted by the public and seems not to have resulted in turbulences at the land and real estate markets.

3.2 Germany

Whereas a few federal states in Germany have implemented climate-adjusted design values more than two decades ago, some other consider projections of climate change too uncertain to be taken into account in flood risk management. One of the considerations for not including such information is the position in Europe being on one hand in the western area where projections are relatively consistent as compared to the eastern part of Europe and Germany where precipitation projections are more divergent. Despite cultural and historical differences across German regions and their exposure to distinct major flood events, there is strong potential for mutual learning and knowledge transfer.

In NRW (Germany), the 2021 floods acted as a major wake-up call, triggering significant organizational and structural changes in flood risk management. NRW has developed a 10-point action plan to address climate change in FRM including assessments of future extreme rainfall and flood design values.

3.3 Wallonia

Wallonia follows a pragmatic approach to integrate climate change scenarios and impacts into flood risk management policies. The region has identified a long-term climate strategy and climate adaptation is addressed strategically with a long-term perspective. Some specific hotspots of high flood risk are prioritized in FRM activities (e.g. Vesdre). New scientific research shows that the 2021 July event in the Vesdre valley will probably have a 20-year return period in a +3 degree world. Up till now Wallonia did not use official climate scenarios in FRM. Yet, a new set of locally applicable climate scenarios was presented by the University of Liege.

Key issue in Wallonia is the difficulty of raising awareness about the uncertainty of long-term climate change. This makes the issue difficult

to communicate to the general public. There is a need to strengthen scientific communication with policymakers and the general public.

3.4 The Netherlands

The Netherlands has a long-standing experience by the Dutch (regional) water authorities. They have a high level of independence, a strong funding basis (via taxes), and a large workforce to implement water management - which is a national top priority. The Netherlands seeks for international cooperation via dedicated working groups and committees. A holistic stakeholders approach is followed, which ensures that implemented measures are supported by the different sectors and to maximize benefits of FRM across a wide range of stakeholders.

There are official national (probabilistic-) climate scenarios provided by the KNMI. Deltares and Rijkswaterstaat update these scenarios every 10-12 years into updated design values for embankments along the larger rivers, using updated discharge frequency curves with a method called GRADE.

Water boards in principle use the climate scenarios for regional water systems as well, but there is inconsistency in approaches between regions. In addition, stress tests and synthetic extreme event analysis from weather generators are used to assess the value and design FRM measures. The implementation of climate scenarios into FRM actions has a strong focus on extremes (drought and heavy rainfall). In this process, cooperation and financing are seen as key drivers: Multi-stakeholder engagement, high farmer participation, involvement of banks and financial institutions, and informal networks are seen as crucial for advancing FRM implementation.

4 Key challenges

In break-out sessions, the key challenges in developing and using climate scenarios in FRM were discussed. Below we summarize the main discussions.

Communication and acceptance

All of the FRM practitioners have a very clear message: climate scenarios should be simple so that the general public and FRM policy makers understand them. While scientists emphasise structural and GCM-driven uncertainty, practice demands simple, actionable recommendations. There is discussion between countries whether scientists or practitioners should advise on which scenarios to use.

Uncertainty and the complexity of hazard and risk maps may undermine public trust and insurance frameworks. For example, the use of climate scenarios or return period flood maps (RP100 or RP1000) are difficult to communicate. To overcome this issue, in Flanders, they translate climate projections into financial impacts. Although this requires some communication expertise, it proves effective in convincing policymakers and households to take appropriate action.

A core challenge is not so much the availability of climate projections but choosing and legitimising scenarios for setting design standards such as dike heightening. This requires legal, financial and property-related (binding-) regulations which are not present in all countries yet.

Translating climate scenarios into FRM actions

High impact scenarios are very popular because they convey a very clear message, just like stress tests or 'water bomb' studies. One way to address this is anchoring projections to experienced events (e.g. 2021 flood). Using a single high-impact climate scenario to illustrate the maximum potential impact of climate change, despite high uncertainty, is an effective way to raise awareness and support preparedness. In Wallonia, for example, they compared the 2021 flood with future climate projections, showing that 2021 event falls within the range of potential future changes.

Despite their uncertainty, climate scenarios may be used for stress testing current and planned flood risk management measures. Such additional stress testing information enables authorities or private

actors that manage infrastructure, housing, and crisis managers, to make more informed and robust decisions. Using different climate information in the design of FRM measures in cross border river catchments may lead to upstream-downstream interactions that are not visible in current planning. For example, there are cross border rivers where upstream climate change and increasing future precipitation has not been incorporated in the design of flood prevention measures up to now. Nor have upstream flood protection measures been considered. When upstream regions change their policies and will adapt FRM measures to future climate change by enhancing protection measures such as embankments, this may lead to increased flood hazard in downstream regions.

Another method for stress-testing is the use of advanced weather generators. In the Netherlands, FRM for the main rivers relies on 50,000 years of synthetic rainfall and discharge data generated by a weather generator, allowing for robust statistical analyses and improved prediction of extreme events. These methods are increasingly coupled to climate scenarios and used for design floods.

Governance and cross border issues

Another issue are the multiple institutions that deal with climate change data, which hinders effective development and uptake. In the Netherlands, this is well arranged with the KNMI being the only institution responsible for developing climate scenarios. Furthermore, Dutch water boards benefit from a high degree of autonomy and decision-making power, allowing them to tailor flood risk strategies to local conditions.

In Germany, the diversity of cultural and historical contexts across regions partly explains the significant differences in approaches and levels of progress regarding flood hazard and risk mapping, flood management plans, and flood design policies. These cross-region differences may form barriers in effective basin wide FRM.

Since upstream measures have an effect on downstream FRM, it is very important that cross border policies on climate change are better aligned and consistent. For example, the consistent use of the same climate scenarios in a basin would enhance mutual understanding.

FRM and climate adaptation

A real challenge lies in defining strategies for climate-adapted flood design policies and actions, particularly regarding how to progressively

adapt infrastructure over time. In this context it was mentioned that nature-based solutions offer greater flexibility and reversibility, while grey infrastructure should be designed using adaptive and modular approaches that allow for future adjustments (i.e. adjustable and over time increasing dyke heights) as climate projections evolve.

Participants also agreed that implementation of adaptation measures takes a long time because it involves a lot of bureaucracy and many stakeholders. Since we are not fast enough with technical measures, we have to look at non-technical measures and options. This could include mobile protective walls like in Cologne or preparing the population for evacuation.

FRM and policy

Climate Flood label

A nice example was a 'flood check' developed by the German Association for Water, Wastewater and Waste (DWA): this helps the population and local authorities to check whether everything is in place for anticipating flood risk. It was suggested to further develop this flood check into an official flood or climate label. It appears that local authorities ask for such a label as it is very easy to use: it is a three-day check and a report is produced that is easy to understand, using traffic light techniques.

Some people, however, do not want to be flood-checked because they fear that they will then not be able to sell their house at a higher price or that their insurance will become more expensive. So far, these problems were not experienced in Flanders. In Limburg, the Netherlands, they are studying the approaches used in Belgium and Germany.

Insurance schemes

Insurance systems are evolving into governance instruments, ranging from mandatory schemes (Wallonia) to risk-based classifications (Germany, Flanders), with increasing pressure on property owners through insurability after extreme events. In the Netherlands and Germany, there is a big debate about whether there should be compulsory insurance, like in France and Belgium. In Belgium, the experience is that everyone, regardless of whether they live in a risk area or not, has some form of natural disaster insurance. People in general accept such insurance and the trust in climate information is high.

Insurance is very important during the recovery and rebuilding phase. It allows an impacted region to mitigate socio-economic effects and recover wellbeing from communities. Extensive information is now available on how to best finance recovery and rebuild more resiliently through compensation and insurance mechanisms.

EU Flood directive

Our comparison showed that the implementation of EU Flood Directive hazard and risk maps differ significantly across the countries and regions. Flanders integrates climate scenarios into binding spatial planning. Wallonia uses flood hazard zones to raise awareness of communities who live in these areas and also applies restrictions on developments in high hazard zones.

Flood risk management and spatial planning

Land-use regulation is a key leverage point, with Flanders enforcing stricter proof-of-no-harm and compensation mechanisms, whereas other regions struggle with continued development in flood-prone areas and lack of compensation for relocation.

5 FRM support by Science

Based on the key challenges identified in the previous chapter, the workshop participants have summarized activities how science can assist FRM in anticipating future climate risks:

Stress testing

- Science can support the development of more simple climate scenarios. This could entail to support setting up **stress tests** and testing FRM under extreme events that are likely to occur in future climate. The workshop recommended such studies because of their simplicity which makes communication and the implementation of FRM more easy.
- **Weather generators and synthetic events** can also help stress testing current and planned FRM measures.

Communication

- Science can assist in testing which **climate communication strategies** trigger FRM action on the ground. This can be done via interviews with experts, surveys and choice experiments.
- The example from Flanders shows that risk modeling can support **translating climate scenarios and flood mapping into socio-economic impacts.** Research shows that impact analysis triggers people's FRM actions on the ground.
- Communication of uncertainty information needs to be simplified as it currently may result in inaction. Choosing a single scenario, like in Flanders, increases the local uptake.

Cross border cooperation

- Scientific networks such as JCAR ATRACE can **stimulate cross-border coordination** by providing an overview of existing approaches and comparing them in the context of different FRM applications. This fosters the exchange between regions using the same knowledge base.
- There is a need for an improved comparison for assessing **upstream-downstream effects**. For this, there is a need to connect the research in smaller catchments to scientific developments in the larger Rhine and Meuse basins. This may support the development of consistent climate and adaptation scenarios for the whole Meuse & Rhine regions.

Combining FRM measures

- To seek for **combinations of FRM measures** (protection, prevention, NBS, insurance) that may mitigate future flood risk.
- Test different **insurance schemes** under climate scenarios and show if insurance can provide incentive to households to enhance FRM.
- To assess the need for **financial compensation during the recovery** phase.

FRM Policy

- Assess the effects of implementing **flood – or climate labels**, to enhance resilience of local communities and support spatial planning. Science could make a survey in Flanders to assess the effects of the existing label, analyze and showcase best practices.
- More assistance is required on the **role of spatial planning within flood risk management.** For example, what policies are effective in stimulating resilient urban development in flood zones?

6 Conclusions

The workshop focused on the exchange of experiences and mutual learning on the incorporation of climate scenario information into flood risk management (FRM) in various countries (Benelux + Germany). The discussion also covered enhancing cross-border cooperation and stimulating the exchange of knowledge and practices on climate information use in FRM. It was an energetic meeting where the format and exchange ensured all scientists and FRM practitioners got a clear understanding of the different approaches in the various regions.

The national and regional FRM practices have been compared and summarized by the JCAR consortium partners in a new article in the Journal of Flood Risk Management. This paper describes the existing practices in the various countries and regions in NW Europe.

All of the FRM practitioners have a very clear message: climate scenarios should be simple so that the general public and FRM policy makers understand them. While scientists emphasise structural and GCM-driven uncertainty, practice demands simple, actionable recommendations.

A good substantive basis for the discussion was the contribution by Flanders. They showed how flood risk mapping (current and future), and assessing potential impacts to communities, can be translated into effective spatial planning policies.

While there are large differences across the regions in how they integrate climate data in their FRM practices, all participants agreed that more cross-border cooperation is required to enhance coordination of methods and data.

Science can support FRM policy making with a number of activities, such as:

1. Help setup stress testing studies to evaluate current and future FRM measures.
2. Evaluate climate communication strategies to improve the integration of climate data into FRM activities.
3. Enhance cross border cooperation using climate scenarios and FRM plans to quantify (future-) upstream-downstream effects.

4. Conduct studies in the combined effect of different FRM measures (e.g. protection, prevention, NBS, insurance, etc.) to evaluate how to best mitigate future flood risk.
5. Assess the effects of flood – or climate policy labels as potential best practices to enhance resilience of local communities. Here research is needed on the role of spatial planning within flood risk management.

7 Presentations

The presentations can be downloaded as an annex.

8 Workshop agenda

Organised by

IWW | RWTH AACHEN UNIVERSITY | GFZ Helmholtz Centre for Geosciences | Deltares

Climate Change and Flood Risk Management in the Benelux Countries and Germany

International workshop for practitioners and researchers

On February 18 and 19, 2026, we will discuss the use of climate change information in flood risk management practice in Belgium, Netherlands, Luxembourg and Germany during an international workshop, to learn from each other's approaches. This event will be organised under the umbrella of the JCAR ATRACE initiative, and is supported by competent national authorities of North Rhine-Westphalia, The Netherlands, the Benelux union and Deutsche Hydrologische Gesellschaft (DHG).

For the discussions we invite practitioners from competent authorities in the field of flood risk management, such as ministries, regional water authorities, river basin commissions and environmental agencies from the Benelux countries and Germany. The discussions will be introduced by a few keynote speeches from leading practitioners and scientists from the different countries. In breakout working sessions we will explore the potential for mutual learning by cross-border cooperation and how coordination between the regions could improve this. The workshop will be bilingual: English and German.

Please find the agenda and practical information in the annex and please register yourself to workshop via the registration link.

Also on behalf of Prof.dr. Holger Schüttrumpf (RWTH Aachen) and Prof.dr. Bruno Merz (GFZ Potsdam).

Dr. Kymo Slager
Program manager JCAR ATRACE, Deltares

JCAR ATRACE

Schedule

18-02-2026, Wednesday afternoon

WHAT IS NEEDED BY PRACTICE

Use of climate change information in FRM practice

Current practices using climate change information by flood risk managers

12.30 hrs	**Reception, registration and lunch**
14.00 hrs	**Opening and welcome** Minister Oliver Krischer, Minister for the Environment, Nature Protection, and Transport of the State of North Rhine-Westphalia
14.15 hrs	**Plenary presentations** Current practices and needs in Benelux countries and Germany - Mr. Fabian Gier (MUNV, NRW) - Mr. Hein Pieper (Waterschap Rijn en Ijssel, NL) - Mr. Nicolas Feltz (Service Public, Wallonie) - Mr. Fernando Pereira (WL, Vlaanderen) & Mr. Maarten Vandecasteele (VMM, Vlaanderen)
15.30 hrs	**Tea and coffee break**
16.00 hrs	**Break out working sessions 1** What do we like from each other's practices / approaches?
17.30 hrs	**Closing session** The impact of climate change on FRM in the River Rhine Prof.dr. Jaap Kwadijk, Deltares
Evening	**Joint dinner in Aachen (catering at RWTH Aachen)**

JCAR ATRACE

Schedule

19-02-2026, Thursday morning

WHAT CAN BE PROVIDED BY SCIENCE

State-of-the-art in climate change information for FRM practice

Presentations and discussion on the current availability and utility of climate change information

09.00 hrs	**Opening and recap of day 1**
09.10 hrs	**Future climate change assessment in flood risk management** A synthesis of practices in Germany and the BeNeLux countries Dr. Sergiy Vorogushyn, GFZ Helmholtz Centre for Geosciences
09.30 hrs	**Plenary presentations** What can science offer, what makes that information is used and what are the challenges? Prof. Xavier Fettweis, Université de Liège Prof. Patrick Willems, KU Leuven Dr. Frederiek Sperna Weiland, Deltares
10.30 hrs	**Tea and coffee break**
11.00 hrs	**Break out working sessions 2** Which information provided by science is useful / need attention to improve preparedness of FRM to climate change?
12.15 hrs	**Closing session** Climate change information for FRM practice, ideas on the way forward and follow-up steps Prof. Dr.-Ing. Holger Schüttrumpf, RWTH Aachen
13.00 hrs	**Lunch** (package)