



**European Strategic Actions
in Water and Climate Change
Policy Booklet**



INTRODUCTION

We are living in an increasingly complex, interconnected, and uncertain world. The variously attributed adage, "It is difficult to make forecasts, especially about the future" has never seemed truer. Decision makers in all walks of life are grappling with the consequences, and have worked to reduce the uncertainty of their predictions through more and more sophisticated forecasting techniques. Gradually, however, a movement has emerged that accepts the reality of a complex future and shifts the emphasis to effective reaction over prediction. The software engineering sector adopted the motto "embrace change" with its agile development methods; the business sector subsequently popularized agile management; and policy makers are increasingly applying an approach known as foresight – a powerful set of systematic, participatory, future-intelligence-gathering and medium to long-term vision-building processes to uncover a range of possible alternative future visions and build effective, agile policy capable of confronting these alternative futures. European Commission President Juncker himself applied foresight in 2017 when he hypothesized a range of scenarios for the Future of Europe, providing policy makers with a framework for fruitful debate of alternative strategies.

Nowhere is an unpredictable future becoming so evident as in climate change. Not only are climate events becoming more extreme, but they are also becoming more interconnected, often occurring simultaneously, with unforeseen consequences. The European Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) communities are rising to the challenge by harnessing the tools of flexible policy development offered by foresight methods, and by improved identification of the emerging sources of uncertainty linked to climate change. The projects represented in this set of policy briefs are directly contributing to reducing the uncertainty of near-term climate predictions and developing response strategies that may help society to better manage the remaining uncertainty. They recognize that the future will involve more and more interconnected events (such as storm surges coupled with high levels of precipitation), and that such "compound" events must be elevated to first-class citizens in climate research. They realize that long-term, slow climate change will be combined in unexpected ways with periodic extreme events. And they understand that climate policy development must evolve accordingly, complementing forecast with foresight, in order to navigate successfully the coming climate disruptions and preserve a safe and secure environment for all Europeans.



INDEX

- ⌚ THE IMPORTANCE OF INCLUDING COMPOUND EVENTS
IN THE IMPLEMENTATION OF THE FLOODS DIRECTIVE *page 4*

- ⌚ WEATHER WORRIES
THE FUTURE OF EUROPE DEPENDS ON HOW
IT MANAGES THE RISKS OF CLIMATE EXTREMES *page 8*



The information, views and recommendations set out in this publication are those of the IMPREX and PLACARD consortia and do not reflect the views of the European Commission. These projects have received funding from the European Union's Horizon 2020 (H2020) Research and Innovation programme under Grant Agreements: IMPREX 641811; PLACARD 653255.



THE IMPORTANCE OF INCLUDING COMPOUND EVENTS IN THE IMPLEMENTATION OF THE FLOODS DIRECTIVE

IMPREX POLICY BRIEF

MAIN MESSAGES

The phenomenon known as compound flooding, caused by the coincident occurrence of multiple flood drivers such as high precipitation events, storm surges or high runoff rates, has caused some of the most destructive flooding in Europe. To date, however, the compounding nature of multiple drivers has not been given sufficient consideration in current flood hazard and risk scenarios developed, for example, in the context of the Floods Directive. This may lead to a biased assessment of flood risk, both for current and future climate conditions.

IMPREX puts forward a host of reasons as to why it is important to incorporate compound events into flood hazard and risk assessments, providing related methods and tools:

- Incorporation of compound events can enhance the reliability of flood statistics and consequently flood hazard maps;
- Probability of compound events may change in the future climate;
- Compound events may call for different flood measures, making it imperative to factor them into the flood risk management plans drawn up.

→ Better understanding of the emergence and impact of compound events is needed. Particular attention should be paid that the correlation between flood drivers is quantified more clearly. More emphasis on and support for related research is needed.

→ Awareness and knowledge of compound events needs to be increased at all levels of river basin management.

→ Compound events should be factored in at every stage of implementation of the Floods Directive. The explicit mention of compound events in the Floods Directive as well as in related Guidance Documents should be given proper consideration.



BACKGROUND

In October 1998 and January 2012 in Delfzijl in the north of The Netherlands, discharge of heavy precipitation on the polder to the sea was blocked due to storm surges happening at the same time, leading to unprecedented flooding. The 2013/2014 flood in the South West of the UK was caused by heavy precipitation on an already saturated soil in combination with high ocean water levels. A common feature of these events was that they were caused by the joint occurrence of two or more drivers, such as heavy precipitation, storm surges at sea or increased water levels in a river, which ultimately led to these extreme events. Even though compound events are known for causing some of the worst flood events, they have often been viewed as an ancillary issue in hazard and risk assessments owing to the difficulties in characterizing and predicting them. Research has shown, however, that compound floods are not only among the most destructive but are also far more common in Europe than often perceived, which is why it is all the more imperative that they be taken into account in flood statistics as well.

Within the framework of the Floods Directive all Member States are obligated to put in place flood

risk management plans to prevent, prepare for and ensure protection from flooding. In line with the Directive, flood hazard and risks are assessed in order to define flood scenarios for different return periods. The Floods Directive accounts for the great variety of flood causes by urging Member States to prepare for different types of floods that are relevant in their territory. Neither in the Floods Directive nor in related Guidance Documents, however, are compound events mentioned. Further, compound events are not sufficiently taken into account when developing flood hazard maps in the Member States. In light of the current debate on how to make Europe fit for future climate and weather conditions, compound events could well become even more relevant, especially given the potential impact that changes in weather patterns and the projected sea level rise - a new flood driver - have on the probability of occurrence of compound events.

The research project IMPREX has explored the occurrence of diverse examples of compound flood events for the current as well as the future climate in five case studies in the Netherlands and in the UK. The results underline the need to factor in compound events in implementing the Floods Directive.



RELEVANCE OF COMPOUND EVENTS

Compound events can cause extreme flood events even if individual drivers are not extreme in themselves

Compound events can be found in any areas of natural hazards, for example, droughts, wildfires, storms and floods. Multiple definitions of compound events have been proposed. The common denominators of most definitions are, however, the coincident or consecutive occurrence of more than one driver, resulting in amplified risk and, ultimately, an extreme (e.g. flood) event. It is important to mention that the individual drivers of compound events in themselves do not necessarily have to be extreme to cause an extreme hazard. Even average precipitation, for example, can cause flooding if it occurs in combination with previously saturated ground. IMPREX has developed methods to estimate the likelihood of different cases of compound flood events.

Incorporation of compound events can enhance the reliability of flood statistics and consequently the reliability of flood hazard maps

One of the challenges faced in implementing the Floods Directive in Member States is the development of reliable flood statistics as the basis for flood hazard maps. Usually flood probabilities are derived from historical flood data that is integrated into hydrological models used to derive useful statistics. Future climate conditions are mapped by manipulating or replacing the input data with information from future climate projections. For events that are governed by multiple drivers, assumptions are made on the statistical correlation between these drivers, which have a big impact on the outcome of the flood probability estimate.



A difficulty that stands in the way of an accurate derivation of the correlation structure is that observational records are only available for limited time spans, which may not cover very extreme events driven by a rare combination of multiple drivers with an unknown mutual dependence. This in turn may lead to biases in the derived flood statistics and risks. On the basis of a number of case studies of compound flood events, IMPREX has enhanced the understanding of the statistical dependence of flood drivers. For instance it provided a method involving a high resolution regional climate model simulation for current and future climate conditions, which was coupled with hydrological and/or hydraulic models. It provided much longer time-series of relevant variables than available from observations. This approach was used to analyze statistical dependencies between drivers of flood events when deriving flood risk. This method was applied to different case studies in order to quantify the effect of the dependency between flood drivers and how this might change in future climate. The method was thus shown to be transferable to other applications.

The results highlight not only the need to incorporate compound events into flood hazard assessments. In fact, they also show that it is possible and should be further explored for the implementation of the Floods Directive.

Probability of occurrence of compound events may change in future climate

One of the biggest unknowns in climate research is the effect of the changing climate on weather patterns. This leads to great uncertainty in future climate scenarios and, consequently, flood scenarios. This also gives rise to challenges for Member States when it comes to drawing up flood hazard maps in the context of implementation of the Floods Directive. When considering changing weather patterns it is important not only to look at changing patterns of isolated flood drivers but also to explore more deeply how climate change alters the correlation structure between such drivers, as this may affect the probability of compound events. A change in the correlation between drivers can be caused by altered large-scale atmospheric circulation patterns affecting storm statistics, or changes in hydrological phenomena that affect flood risk, increasing or decreasing it accordingly; in both

cases, the potential impact on the financial risk and preparatory measures is substantial. For this reason, a better understanding of the driving forces behind compound events is paramount.

The current debate on how to give greater consideration to climate change impacts in flood hazard and risk maps should not leave out the potential changes in the probability of extreme events due to compound scenarios.

Compound events may call for different flood measures, making it imperative to factor them into the flood risk management plans drawn up

The Floods Directive requires Member States to select appropriate flood measures based on a prior assessment of flood hazard and risk. When it comes to choosing flood measures that also take compound scenarios into account, however, there is limited understanding and experience. This becomes especially critical if flood measures designed to counteract flooding caused by individual drivers, fail in compound events. IMPREX has investigated a few such cases which show that compound events may require different flood measures than those that would be necessary if the driver were to occur on its own. One case study shows how the coincidence of extremely high river discharges of River Rhine and Meuse in combination with storm surge off the Dutch coast and projected sea level rise does not allow for the water to be discharged to the sea, which in turn leads to a huge flood risk resulting from the fact that the flood measures can no longer work here. The same holds true for another case study, where the simultaneous occurrence of peak flows meant two rivers (Dommel and Aa) were no longer able to discharge into the River Meuse, resulting in severe flooding.

The outcome here shows how vital it is to take the risk of compound events into account when evaluating suitable flood measures, for example, when putting together programmes of measures as part of flood risk management plans.

RECOMMENDATIONS

IMPREX not only provides evidence on why proper consideration of compound events is much needed also in the context of implementation of the Floods Directive, but also shows how compound events can be incorporated into flood statistics, enabling better preparation and protection from some of the most destructive floods ever seen. Based on the work conducted within IMPREX, the following recommendations are made:

- **Improve the understanding of compound flood events and the correlation between drivers through research.** The integration of compound events into flood scenarios is crucial to be able to accurately gauge the probability of extreme events and improve flood statistics. Better understanding of underlying meteorological and hydrological processes of compound events is needed. A first step has been taken in the form of the European COST action DAMOCLES, a recent initiative (involving IMPREX partners) that seeks to coordinate research and improve the assessment of compound events.
- **Raise awareness of compound events with policy and decision makers and strengthen related management capacities.** Several EU Member States have had hands-on experience with compound events. This experience should be actively shared in order to deepen our knowledge and bridge the gap between research and practice.
- **Include compound events in the European policy framework for flood risk management.** Flood risks resulting from compound events need to be taken into account at every stage of implementation of the Floods Directive, from deriving flood statistics and developing flood hazard maps to determining flood measures. Proper consideration should therefore be given to the possibility of explicitly specifying compound events as a potential flood source in the Floods Directive as well as in related Guidance Documents

About IMPREX

IMPREX is designed to help reduce Europe's vulnerability to hydrological extremes by achieving a better understanding of the intensity and frequency of potential disrupting events. Enhancing our forecasting capability will increase the resilience of European society as a whole, while reducing costs for strategic sectors and regions at the same time. The research project brings together 23 partners from 9 countries and has received funding from the European Union's Horizon 2020 Research and Innovation Programme. This policy brief was compiled by adelphi based on the work done within the context of the research project IMPREX with special contributions by Bart van den Hurk (Deltares), Dorien Lugt (HKV Consultants), Emma Aalbers (Royal Netherlands Meteorological Institute) and Albrecht Weerts (Deltares). Graphic design by Arctik.

Coordination and Contact

Bart van den Hurk
 Deltares
 P.O. Box 177, 2600 MH Delft, The Netherlands
bart.vandenHurk@deltares.nl

Janet Wijngaard
 Royal Netherlands Meteorological Institute
 P.O. Box 201,3730 AE De Bilt, The Netherlands
janet.wijngaard@knmi.nl

 Visit www.imprex.eu and engage with us!

 Follow us on Twitter @imprex_eu





WEATHER WORRIES

THE FUTURE OF EUROPE DEPENDS ON HOW IT MANAGES THE RISKS OF CLIMATE EXTREMES

PLACARD POLICY BRIEF

WHY THE EU SHOULD WORRY ABOUT THE WEATHER

Geo-political power shifts, uncertain economic development, migration, populism, BREXIT – Europe lives in tumultuous times with multiple challenges. In 2017, President Juncker started a debate on the Future of Europe: What future do we want for ourselves, for our children and for our European Union? A White Paper mapped out the drivers of change in the next decade, presenting a range of scenarios for how Europe could evolve by 2025.

The emphasis is on the choices to be made to shape the unavoidable transformation of the Union rather than to be carried with them. That same year, three European think tanks emphasised that climate change should be one of the key challenges that need to be addressed in this process. These focused mainly on mitigation: the challenges posed by the energy transition required to meet the goals of the Paris Agreement, of which the EU was one of the main driving forces. However, even if the goals of Paris would be achieved, and even more so when these goals would not be achieved, Europe's future will be affected by both

slow-onset climatic changes but also by the changing occurrence of extreme weather events.

In recent years, large scale floods, freak storms, heatwaves and scorching droughts have already affected large parts of Europe. Their frequency and scope is projected to increase and may increasingly exceed the capabilities of individual Member States to save lives and limit economic damage.

The frequency and scope of extreme weather events is projected to increase and may increasingly exceed the capabilities of individual EU member states to save lives and limit economic damage.

5 DIFFERENT FUTURE SCENARIOS FOR THE EU



1 Carrying on:
The eu27 focuses on delivering its positive reform agenda

2 Nothing but the single market:
The eu27 is gradually re-centred on the single market

3 Those who want more do more:
Willing member states do more together in specific areas

4 Doing less more efficiently:
A focus on delivering more faster in selected areas, doing less elsewhere

5 Doing much more together:
Member States decide to do much more together across all policy areas

Source: White Paper on the Future of Europe – Reflections and scenarios for the EU27 by 2025 (EC, 2017)

CHOICES ABOUT THE FUTURE OF THE EUROPEAN UNION HAVE UPSIDES AND DOWNSIDES FOR CLIMATE RISKS

At first sight, a scenario in which Member States would do much more together would offer the best opportunities to enhance future resilience and manage climate risks. Existing mechanisms like the Union Civil Protection Mechanism and the EU Strategy on Adaptation to Climate Change along with their supporting implementation mechanisms like knowledge networks, pooled resources and solidarity-based funding schemes could readily be strengthened. The EU's position in international climate negotiations would be bolstered. However, such a scenario also has the pitfalls of over-regulation, sluggish coordination and a mismatch between the slow development of formal guidelines and frameworks on the EU level versus the needs of fast decision-making to address urgent climate risks at local and regional levels. Expansion of the EU may further dilute or slow down CCA and DRR response capabilities.

In a scenario in which the EU would re-center its focus on the single market, much less coordination and cooperation can be expected in prevention, preparedness, response and recovery, and increased inequality between regions can be expected. However, this scenario may lead to innovative market-driven solutions to climate risks, boosted by an increasing role of the private sector, including but not limited to financial instruments like in the insurance business.

A scenario in which the EU would re-center its focus on the single market could lead to innovative market-driven solutions to climate risks boosted by an increasing role of the private sector.



In a scenario in which a limited number of Member States with similar challenges would enhance their collaboration on climate risks ("coalitions of the willing"), there would be a greater disparity in the rate of development between Member States with regards to science, economy and security and differences in the willingness to act. But Member States facing similar issues can move faster in developing solutions without waiting for other Member States to move at the same speed. This can lead to a tailored approach, with efficient and prompt response capabilities related to specific needs and innovations. Other Member States would have the opportunity of joining over time. In a scenario in which the EU would do less but more efficiently, obviously future climate resilience will depend on the selection of CCA and DRR as one of the priority areas.

THE EU'S FUTURE IS UNKNOWN. HOW CAN THE EU MANAGE EXTREME WEATHER RISKS UNDER THIS UNCERTAINTY?

Not only from a governance, but also from a climate perspective, the EU will look completely differently in a few decades. The current EU Strategy on Adaptation to Climate Change and the Union Civil Protection Mechanism require strengthening to effectively address the increasing risks posed by different possible EU futures.

→ It is recommended that DG CLIMA guidance on developing adaptation strategies and DG ECHO advice on Risk Assessment are updated, taking into account the results of foresight work.

→ The forward-looking approaches used in foresight should be showcased for all relevant actors, in order to help them to prepare for the range of possible futures across Europe.

A scenario in which Member States would do much more together would offer the best opportunities to enhance future resilience and manage climate risks.

→ Advances that have been made in sharing of data, knowledge and good practice can be sustained, but also weakened or even nullified, depending on the direction the EU takes. Therefore, specific guarantees with effective institutional and financial support have to be developed both at the EU level and between Member States, in order to sustain or enhance existing mechanisms and ensure resilience in an uncertain future.

→ There is a need for the continued building of a CCA and DRR expert community that should be at least partially independent from EU funding.

→ Collaboration and cooperation between actors across administrative borders should be strengthened and agreement on logistics, legislation, distribution of resources between the EU and MS actors pursued.



About PLACARD



PLACARD (PLAtform for Climate Adaptation and Risk reDuction) is a platform for dialogue, knowledge exchange and collaboration between the Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) communities. In the large and complex landscape of stakeholder networks, research, policy initiatives and information sources, PLACARD enhances the coherence of and gives direction to CCA and DRR research, policy and practices, strengthening cooperation and countering fragmentation between the domains. This PLACARD policy brief is based on a foresight workshop which was held from 11-12 December 2018 in Brussels. Upsides and downsides, challenges and response actions were discussed for 3 of the 5 scenarios from the EU White Paper on the Future of Europe and three climate cases (floods, heat waves and droughts, and storm surges).

This policy brief was authored by Markus Leitner and Rob Swart in March 2019

Reference

Leitner, M., Coninx, I., Swart, R. and Lourenço, T.C. 2019. Foresight workshop summary: The future of Europe depends on how it manages the risks of climate extremes. PLACARD project, FC.ID, Lisbon.

Further reading

The future of Europe and the future of climate action: reflections and scenarios for the EU27 by Gaventa, J., Dufour, M., Nesbit, M., Paquet, K and Primova, R. (C3S, 2017) and the White Paper on the Future of Europe – Reflections and scenarios for the EU27 by 2025 (European Commission, 2017).

 Visit www.placard-network.eu

 Follow us on Twitter @placard_eu





CONCLUSIONS

The policy briefs presented in this booklet exemplify a two-pronged approach emerging within the CCA and DRR communities:

- ⌚ Improve our short-term prediction capability by adapting to the new realities of climate change. This means not only studying and tracking ever-more frequent extreme single events, but also identifying new trends such as the formation of extreme compound phenomena and raising awareness about them in research, response, and policy-making groups.
- ⌚ Acknowledge the fundamental uncertainty that will underlie future climate change management and adopt methodologies – particularly the processes of foresight development – that increase our capacity for elastic, flexible policy development appropriate to confronting the challenges that lie ahead.





These projects have received funding from the European Union's Horizon 2020 (H2020) Research and Innovation programme under Grant Agreements: IMPREX 641811; PLACARD 653255.