REPORT 2019:03

Physical climate risk

Investor needs and information gaps

Clim INVEST

Tailored climate risk information
for financial decision makers

Project ClimINVEST is part of ERA4CS, an ERA-NET initiated by JPI Climate, and funded by RCN (NO), ANR (FR), NWO (NL) with co-funding by the European Union (Grant 690462)

°CICERO Climate Finance

Physical climate risk: Investor needs and information gaps

11 March 2019

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Title: Physical climate risk: Investor needs and information gaps

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Financed by: Research Council of Norway (RCN), French National Research Agency (ANR), Netherlands Organisation for Scientific Research (NWO) with co-funding by the European Union (Grant 690462).

Project: ClimINVEST, a part of ERA4CS, an ERA-NET initiated by JPI Climate

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Keywords: : financial sector, investor needs, physical climate risk, climate services, France, the Netherlands, Norway

Abstract: While investors are paying more attention to climate change, there is a lack of granular data designed to support financial decisions. Climate science can provide improved indicators and metrics to help investors better manage physical climate risks. This report presents the first results of the ERA4CS-JPI Climate project ClimINVEST aimed at co-designing tailored information on climate change. We provide an overview of investors' needs and information gaps regarding the physical impacts of climate change. We identify the information sources that financial actors rely on and the challenges they face in decision-making incorporating available climate change information while taking into account diverse investor mandates and risk management approaches. The user needs identified underscore the need for collaborative efforts between researchers and the financial sector on improving climate risk information.

The report presents three geographical case studies – France, the Netherlands and Norway. These countries are at the forefront of creating awareness and acting on the risks and opportunities of the physical impacts of climate change in the financial sector. The cases provide unique perspectives on the country-specific contexts and initiatives related to physical climate risk and user needs, featuring both commonalities and differences.

In France, the 2015's Energy Transition for Green Growth Act (Article 173-VI) requires institutional investors to report on their integration of climate-related risks in their investment policies. In the Netherlands, the Dutch Central Bank and financial institutions are challenged to deal with potential flood risks from more frequent precipitation and sea level rise. In Norway, actors such as Finance Norway and the Norwegian government are assessing the risks from physical impacts of climate change on the Norwegian economy.

Language of Report: English

Acknowledgements: This work received financial support in the frame of the ClimINVEST project, which is part of ERA4CS, an ERA-NET initiated by JPI Climate, and funded by RCN (NO), ANR (FR), NWO (NL) with co-funding by the European Union (Grant 690462). The Joint Programming Initiative "Connecting Climate Knowledge for Europe" (JPI Climate) is a pan-European intergovernmental initiative gathering European countries to jointly coordinate climate research and fund new transnational research initiatives that provide useful climate knowledge and services for post-COP21 Climate Action.

A special thanks to the helpful inputs and review from Jana Sillmann (CICERO), Kristina Alnes (CICERO), Asbjørn Torvanger (CICERO), and Michel Cardona (I4CE)

Graphical illustrations: Eilif Ursin Reed (CICERO)

Full reference: Bruin, K. de, R. Hubert, J. Evain, C. Clapp, M. Stackpole Dahl, and J. Bolt (2019). Physical climate risk. Investor needs and information gaps. CICERO Climate Finance – ClimINVEST project.

ClimINVEST – WP1 – Deliverable 1.4 – website: www.cicero.oslo.no/en/climinvest

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Executive summary

While investors are paying more attention to climate change, there is a lack of granular data designed to support financial decisions. How can investors better secure the value of their portfolios against physical impacts from climate change? Which climate-related risks require immediate attention from investors, and what scientific information is available? Climate science can provide improved indicators and metrics to help investors better manage their risks.

Much of the information available to investors today (such as carbon footprints) ignores the physical impacts of climate change. Improved indicators of non-financial information on climate-related risk, particularly of physical impacts, are needed for making better investment decisions in a changing climate.

To provide insight into climate-related risks and investor needs, the report presents three geographical case studies: France, the Netherlands and Norway. These countries are at the forefront of creating awareness and acting on the risks and opportunities of the physical impacts of climate change in the financial sector. The cases provide unique perspectives on the country-specific contexts and initiatives related to climate-related risks and user needs, featuring both commonalities and differences.

- In France, the 2015's Energy Transition for Green Growth Act (Article 173-VI) requires institutional investors to report on their integration of climate-related risks in their investment policies. These provisions have urged financial actors and regulators to address climate-related risks.

- In the Netherlands, the Dutch Central Bank and financial institutions are challenged to deal with potential flood risks from more frequent and heavier precipitation and sea level rise.

- In Norway, actors such as Finance Norway and the Norwegian government are assessing the risks associated with the physical impacts of climate change on the Norwegian economy.

This report provides a synthesis of investors' needs and information gaps on the physical impacts of climate change, categorized as risk awareness, risk analysis and risk management. The user needs identified underscore the need for collaborative efforts between researchers and the financial sector on improving climate information for risk assessment.

Key user needs:

- Risk awareness: In-house capacity building and training within financial institutions on physical climate impacts to increase risk awareness.
- Risk analysis: Better tools and metrics to assess how the climate changes, including increases in flooding and extreme weather events, and associated physical impacts that affect assets in specific sectors, markets and locations.
- Risk management: Guidance and information to better engage with companies on climate-related risk.

The ClimINVEST project convenes a meeting space between climate change scientists and financial decision-makers to bridge the gap between physical climate risk and financial impacts. The project brings scientists and investors together in a series of science-practice labs to co-design tailored information on climate change to support financial decision-making in the face of physical climate risks and opportunities.

1 Introduction

Investors are paying more attention to climate change, but they still face a lack of granular data designed to support financial decisions. How can investors better secure the value of their portfolios against physical impacts of climate change? Which climate-related risks require immediate attention from investors, and what scientific information is available?

Current practice amongst investors relies on the carbon-footprint, which provides a snapshot based on one performance indicator that ignores the physical impact of climate change. While many forward-looking climate scenarios exist, it is difficult for investors to relate global scale and long-term horizons to indicators of potential physical climate impacts on their investments in specific sectors or locations. Climate scientists often apply indices of weather and climate extremes to illustrate and quantify trends on regional and global scales. However, these indices are primarily designed for use in the scientific community and are not immediately applicable to impact-oriented decision-making in the financial sector. Much of the information available to investors today (such as carbon footprints) ignores the physical impacts of climate change. Improved indicators of non-financial information on climate-related risks, particularly of physical impacts, are needed for making better investment decisions in a changing climate.

Specific assessments of and guidance on interpreting climate-related risk linkages to financial implications are emerging. In June 2017, the Financial Stability Board's Task Force on Climate-Related Financial Disclosures (TCFD) published recommendations on improving the reporting standards for climate-related risks and opportunities (TCFD, 2017). This was followed by initiatives to advance the TCFD recommendations (EBRD and GCECA, 2018), such as banks piloting an assessment methodology that addresses physical risk to estimate the impact of climate change on their agriculture, energy sector and real estate portfolios (UNEPFI, 2018). Moreover, the High-Level Expert Group on Sustainable Finance recommended that the European Commission endorses and implements the TCFD disclosure recommendations at EU level (HLEG, 2018), and in 2018 the central banks and supervisors came together to establish the Network for Greening the Financial System (NGFS). At the same time, a review of corporate disclosures of physical climate change risks and adaptation strategies concludes that many companies either did not report the costs of physical climate change impacts or underestimate them (Goldstein et al., 2019).

The ClimINVEST project brings scientists and investors together in a series of science-practice labs to co-design tailored information on the physical impacts of climate change to support financial decision-making in the face of climate-related risks and opportunities.

This brief report is a synthesis of the first phase of the ClimINVEST project on understanding investors' needs and information gaps regarding the physical impacts of climate change and provides a foundation for collaborating in the design phase to follow. The report identifies what information sources financial actors rely on and what challenges they face in their decision-making based on available climate change information. User needs are categorized as risk awareness (developing and improving understanding of physical impacts of climate change), risk analysis (qualitative and/or quantitative estimation of these risks) and risk management (on identifying and implementing plans, actions or strategies to reduce the implications of these risks). In this study, we focus particularly on the physical impacts of climate change that can affect the financial sector referred to as physical climate risks.

Three unique geographical cases are presented, with both commonalities and differences: France, the Netherlands and Norway. These countries have all been at the forefront of understanding physical climate risk in their respective financial and regulatory environments. In France, the 2015's Energy Transition for Green Growth Act (Article 173-VI and V) requires institutional investors to report on their integration of climate-related risks in their investment policies, and it triggered a dialog between banks, insurers and financial regulators on how to integrate climate-related risks into risk management tools. In the Netherlands, the changing climate is challenging the Dutch Central Bank and financial institutions to deal with potential flood risks from more frequent and heavier precipitation and sea level rise. In Norway, actors such as Finance Norway and the Norwegian government are assessing the risks from physical impacts of climate change on the Norwegian economy.

2 Investor approaches

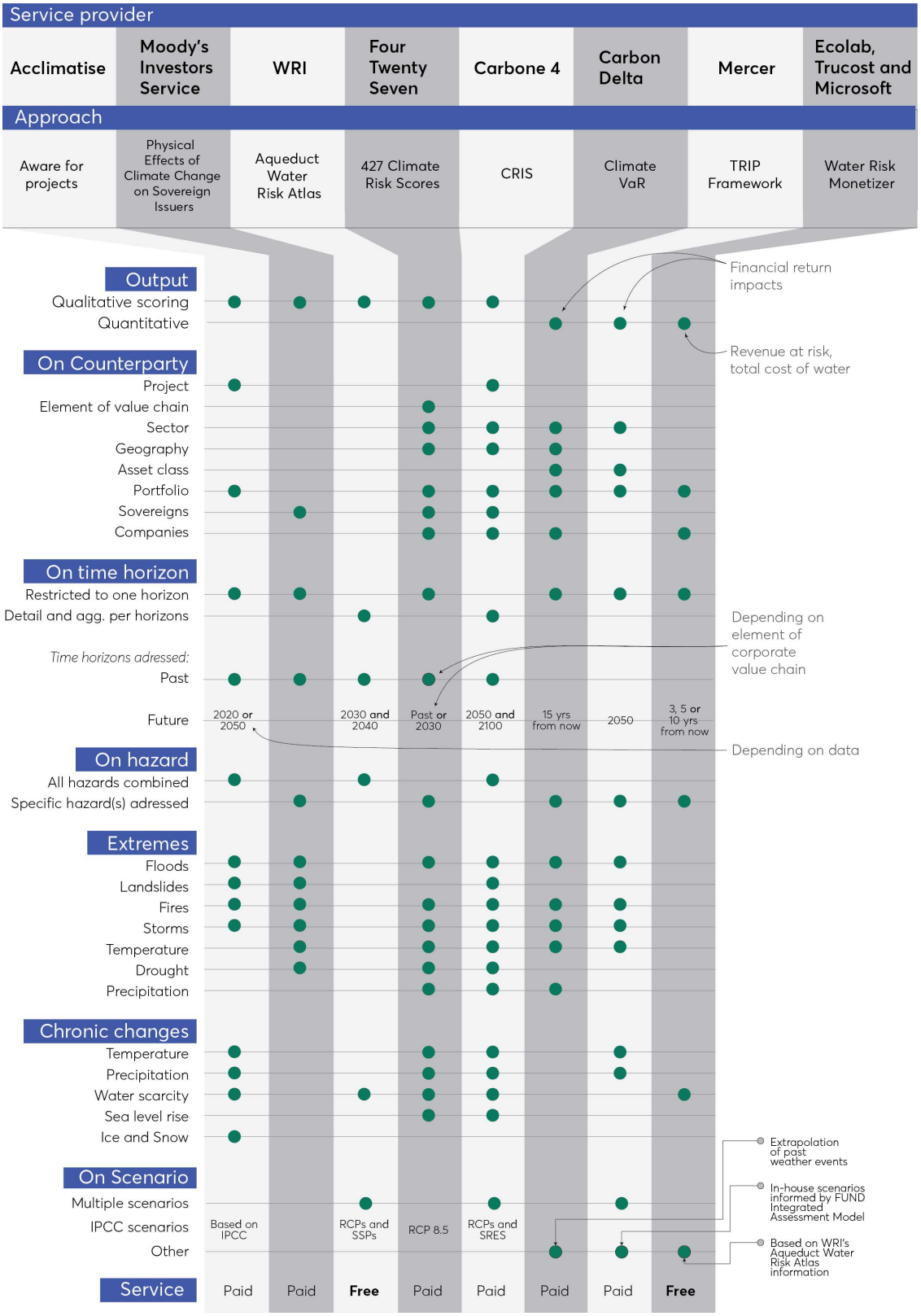
Key points:

- **Financial institutions are beginning to explore physical climate risk with service providers.**
- **Service providers' approaches use diverse information formats and methodologies.**
- **Gaps in existing approaches:**
  - **publicly available approaches cover water scarcity only, while all other approaches are private methodologies covering diverse types of climate hazards;**
  - **limited scenario information (e.g. long-term climate change is often described with only one scenario);**
  - **limited coverage of climate data (e.g. diverse ranges of hazards analyzed in specific time horizons);**
  - **limited transparency of methodologies, resulting in a weak ownership of the outcomes by the management of financial institutions;**
  - **limited tailoring to financial institutions' decision-making processes.**

Current practices

The pool of available approaches to physical climate risk analysis tailored to financial institutions is limited in number. Specialized service providers have developed most of the approaches. Table 1 below provides an overview of these service providers and their detailed approaches. These include Acclimatise (Asian Development Bank, 2016), Moody's (Moody's, 2016), WRI (Gassert et al., 2014; Luck et al., 2015), Four Twenty Seven (Four Twenty Seven & Deutsche Asset Management, 2017), Carbone 4 (Carbone 4, 2017), Carbon Delta (Carbon Delta, 2019), Mercer (Mercer, 2015; Mercer and CalSTRS, 2016), and Trucost (Ecolab, 2017).

Table 1. Details of available approaches on physical climate risk analysis



*) Note that Carbone4 is a research project partner in the ClimINVEST project.
**) Ecolab, Trucost and Microsoft are referred to collectively as "Trucost".
Source: I4CE (2018).

Six of these approaches are available as paid services, while WRI's Water Risk Atlas and Trucost's Water Risk Monetizer are available for free. Note that the providers of free information focus exclusively on water scarcity and do not cover flooding/sea level rise, or anything else on the overabundance of water. The target user for the different approaches are mainly investors, with the exception of Acclimatise, Moody's and WRI. Acclimatise focuses on pre-screening before financing for project officers and risk managers (more suitable for development banks). Moody's provides an exploratory approach that does not constitute a new product to investors and is based on illustrative data for risk managers in all financial institutions. WRI provides an analysis of portfolio exposure to climate hazards for all financial institutions.

Service providers target different end-uses and end-users that are relevant for financial institutions. Nevertheless, they all try to answer the same question: how climate change can potentially affect counterparties[1] such as projects, companies or governments. To investigate potential impacts, the approaches combine information on four broad categories: climate hazards; the counterparty's exposure to these hazards; the sensitivity of the counterparty to this exposure; and its capacity to address these potential impacts. Not all of the selected approaches cover every type of counterparty and every aspect of potential impacts. In terms of analysis of potential impacts, WRI and Trucost focus exclusively on a sub-category of climate hazards related to water scarcity, while the other approaches seek to incorporate different aspects of risk (i.e. information not only on hazards but also on counterparties).

The approaches reviewed build on public data sources on climate hazards which are further processed by service providers internally. The list of climate databases used are easily accessible to service providers. These include climate scenarios and projections (e.g. Representative Concentration Pathways (RCPs) (Van Vuuren et al., 2014)) and various databases with different coverages (e.g. EM-DAT on historical catastrophic events; UNEP-GRID regional databases). The situation differs regarding information on counterparties, related to exposure, sensitivity, and adaptive capacity data:

- The exposure can be provided by the end-user of the approach (in the case of Acclimatise, Trucost and Mercer), or by a combination of the counterparty's publicly reported information and commercial and proprietary databases (in the case of the other selected approaches).
- Sensitivity data can also be provided by the end user (in the case of Acclimatise and Trucost's approaches) or arise from combinations of public and commercial databases, public or proprietary cost functions, and expert judgment (in the case of the other selected approaches).
- The adaptive capacity is addressed for sovereigns with publicly available databases, while it is less covered by corporate counterparties.

Existing approaches provide scores or quantitative estimates with different details. Five service providers choose to provide scores on the level of physical climate risk of the counterparty. Three other approaches produce quantitative information, such as estimates of potential cost or asset value impact resulting from climate-related risks to a single counterparty. This information is produced using a range of normalized methodologies (these are used to create metrics with different techniques to spread the range of results on a given scale, based on quantitative and/or qualitative elements, as well as on expert judgment) and using different scales (e.g. 5-level classification; 0 to 100 scores) and units (e.g. Euros at risk; part of total revenue at risk). The information provided to

1 The counterparty is the entity that receives funding from the financial institution. The selected service providers' approaches aim to provide financial institutions with some information on physical climate risk for one or several types of counterparty: projects, companies or governments.

end users also differs in the type of detail (e.g. per type of hazard, climate scenario, time horizon, category of impact or counterparty) and the level of detail (e.g. counterparty or sectorial level analysis) they provide.

The scope of hazards covered by each approach varies. Most of the current approaches address acute[2] climate-related phenomena (e.g. hurricanes, heatwaves, drought and floods) while coverage of chronic[3] phenomena is emerging (for example some approaches focus specifically on water availability). Climate-related phenomena can be combined with each other. For instance, gradual sea level rise (a chronic phenomenon) exacerbates the magnitude of coastal flooding (an acute phenomenon). Some methodologies show differences in the indicators that describe a given hazard (for example water stress can be studied through mean yearly water supply or intra-year variability of water supply), but several approaches offer limited transparency about the chosen indicators.

In addition, the existing methodologies covered by this analysis address different climate-related impacts on corporate counterparties. They focus on different scopes of the counterparty's exposure; for instance, some methodologies cover the upstream and downstream value chain and the logistics whereas others cover operations only. In the same vein, only a few cover capital, labor, natural resources and the macro context.

Forward-looking analyses are beginning to be integrated into physical climate risk analyses. Service providers often include forward-looking scenario-based analyses for climate hazards with variable time horizons (from 15-years up to 2100) and typically use a single scenario, which is not sufficient to reflect the range of potential long-term risks. These scenarios are either 'trend scenarios' in the sense that they extrapolate trends from the past, or 'exploratory scenarios' in the sense that they extrapolate the future with various possibilities in mind.

Information gaps

The exercise of mapping current service providers' approaches helped identify gaps in the diverse information formats and methodologies provided by the service providers to support investors in making informed decisions. I4CE carried out the review of existing approaches that service providers built and made available on the market as of early 2018. This was done via data collection, building on online information to identify the streams of literature, relevant reports and available approaches and interviews conducted with the different service providers. See I4CE (2018) for more details.

- Limited availability of counterparty-specific data, especially for companies, namely:
    - While exposure of operations and downstream value chain is always detailed at a counterparty-specific level (with data on fixed capital and sales), supply chain exposure is always assessed using sectoral data — and the macro context is seldom explicitly addressed.
    - Sensitivity is always assessed at a sectoral level; it could benefit from micro information specific to each counterparty, as well as from macro information on the business environment.
    - Adaptive capacity is not addressed in the methodologies studied in this report due to the lack of available information.

2 Acute climate-related phenomena are disruptive and event-driven. They refer to phenomena that are typically perceived as a shock to the system. More specifically, they include changes in frequency or magnitude of extreme events such as cyclones, heatwaves, storms, etc.

3 Chronic climate-related phenomena refer to long-term persistent changes in mean and variability of all types of climate patterns. They include for example: sea level rise; changes in mean temperature patterns and chronic heatwaves at the end of the spectrum of temperatures evolution.

- Service providers offer limited coverage of climate data, for instance by selecting hazards analyzed in specific time horizons. The publicly available approaches only cover water scarcity.
- The available approaches make limited use of scenarios of long-term climate change and do not provide scenarios of counterparties' evolutions.
- Cross-comparability between approaches is not possible, as service providers use different information formats, methodologies, and information. This prevents financial actors from using of a combination of methodologies to analyze their different portfolios.
- Barriers for service providers developing their approaches towards comprehensive, transparent and tailored analyses:
    - Comprehensiveness is constrained partly by data availability, especially corporate counterparty-specific data on exposure, sensitivity and adaptive capacity.
    - To some extent, the need to protect proprietary methodologies also limits the capacity of service providers to offer transparency in their approaches.
    - The exploration of specific financial institutions' needs and of necessary developments – such as covering a potentially long-term horizon – are limited in the commercial environment of most service providers, since such an environment usually favors the provision of indicators and tools covering the short-term horizon.

3 Case studies

Key points:

- **In France, the financial institutions have a need for capacity building on physical impacts of climate change, such as training sessions to their internal stakeholders. Limited understanding of physical impacts has so far precluded prioritization of climate hazards.**
- **In the Netherlands, the financial sector has been at the forefront of finding opportunities in the face of climate change impacts on water. The emphasis is placed on possible solutions and opportunities, rather than on risks, creating a more positive perspective for dealing with climate change.**
- **In Norway, the government has recently focused on the economic impact of climate-related risks, including physical impacts on the Norwegian economy within Norway as well as the ramifications of physical impacts outside Norway.**
- **Common needs across the case studies include the need for:**
  - **In-house capacity building and training on physical climate risk awareness;**
  - **assessment of impacts of climate change on sector-specific portfolios;**
  - **consistent, granular data on climate-related risks;**
  - **forward-looking scenario-based analysis and**
  - **understanding of extreme events.**

The selected case studies in this section provide insights into physical climate risk and investor needs in France, the Netherlands and Norway. The cases provide unique perspectives on the context of country-specific initiatives around physical climate risk and specific user needs, their uniqueness and high-level commonalities. The content is based on a survey, interviews, literature review and preliminary conversations held during the first phase of the project. ClimINVEST partner I4CE has done the research in France, Wageningen Environmental Research in the Netherlands and CICERO in Norway. Details will be further elaborated in the next phase of the ClimINVEST project, highlighting different hazards and sectors in different science practice labs. User needs per case study are categorized as risk awareness (developing and improving understanding of physical impacts of climate change), risk analysis (qualitative and/or quantitative estimation of these risks) and risk management (on identifying and implementing plans, actions or strategies to reduce the implications of these risks).

Why these case studies?

France, the Netherlands and Norway are three countries at the forefront of creating awareness and acting on the risks and opportunities associated with physical impacts of climate change in the financial sector. They thereby complement the activities of the Financial Stability Board's Task Force on Climate-Related Financial Disclosures (TCFD), which developed recommendations at a broad level for company disclosure of climate-related risks.

- In France, the 2015's Energy Transition for Green Growth Act requires institutional investors to report on their integration of climate-related risks in their investment policies (Article 173-VI) and plans the implementation of periodic stress-tests on bank portfolios with scenarios that are representative of climate risks (Article 173 V). These provisions have urged financial actors and regulators (the Banque de France (the French central bank) and the French Prudential Supervisory Authority) to address climate-related risks.

- In the Netherlands, the changing climate is challenging De Nederlandsche Bank (the Dutch central bank) and financial institutions to deal with potential flood risks from more frequent and heavier precipitation and rising sea level. Other climate hazards are currently not broadly discussed, as these are not yet considered to affect the country's financial system. Although the drought in the spring and summer 2018 may trigger awareness and analysis of financial risks and opportunities associated with extreme events.

- In Norway, actors such as Finance Norway and the Norwegian government are assessing the risks from physical impacts of climate change on the Norwegian economy. The sovereign wealth fund manager (Norges Bank Investment Management (NBIM)) is a leader in working on climate-related risks.

3.1 France

Country-specific context: France

In 2015, France became the first country to impose legal requirements for climate reporting on institutional investors and asset managers, and to create broader early momentum on disclosing on climate-related risks among financial institutions.

The purpose of Article 173 (V and VI) of the Energy Transition for Green Growth Act has been to encourage financial institutions' in-depth reflection on climate-related issues and on their implications for their activities, and to take action to address them.

Climate-related risks for institutional investors, asset managers and banks are explicitly targeted in Article 173-V and VI of the Energy Transition for Green Growth Act promulgated on August 17, 2015.

Article 173-VI of the Act targets institutional investors and asset managers. It requires them to report on their integration of Environmental, Social and Governance (ESG) issues in their investment policies. Institutions that have a consolidated balance sheet of more than EUR 500 billion are required to report more specifically on the integration of climate-related risks (physical or transition risks) and on their contribution to the green economy.[4] In mid-2017, institutional investors and asset managers released their first yearly reports in accordance with Article 173 requirements on the 2016 financial exercise. The final recommendations of the TCFD were released only in June 2017. This specific context raised early awareness on climate-related issues among investors. This momentum has continued while the government and the financial regulators are taking stock of the first two reporting exercises conducted in the context of Article 173-V.

This law has also impacted banks. Article 173-V states that the French government shall report on the implementation of periodic stress-tests on bank portfolios with scenarios that are representative of climate-related risks. The French Ministry of Finance, the Banque de France and the Supervisory Prudential Authority published a report on assessing climate-related risks for banks at the end of 2016.[5] The process triggered a dialog on supervision between the French banks and insurance companies, and the regulators on climate-related risks (through bilateral meetings and regular surveys). The regulators are now enquiring not only about the future integration of climate-related risks in periodic stress-testing exercises, but also about their integration in day-to-day risk analyses performed by banks and about their level of climate-related risks exposure. In parallel, the Banque de France has taken various initiatives on green finance and acts as the secretariat for the Central Banks and Supervisors Network for Greening the Financial System (NGFS), which was launched at the One Planet Summit in Paris in December 2017.

Financial institutions have started working on several aspects of climate-related risks because of Article 173. It began creating awareness about climate issues within financial institutions, but there is still room for improved understanding. For the purpose of reporting, institutional investors and asset managers have increased internal discussions across divisions on this topic. In some instances, it encouraged collaboration with external service providers in order to get started on climate risk analysis. These financial institutions are now experiencing the need and difficulty in finding information that fits their existing decision-making frameworks. The Banque de France and the

4 For more information on the disclosure requirements under Article 173-VI, see the implementing decree n°2015-1850 of 29 December 2015 article L.533-22-1 of the Monetary and Financial Code at https://www.legifrance.gouv.fr/eli/decret/2015/12/29/2015-1850/jo/texte

5 Direction Générale du Trésor, Banque de France, ACPR, 2016. L'évaluation des risques liés au changement climatique dans le secteur bancaire.

Prudential Supervisory Authority have been putting pressure on financial actors since 2015 to assess and address climate-related risks (Villeroy de Galhau, 2018).

User needs

ESG and risk divisions collaborate on the topic of physical climate risk in all sampled institutions. However, only a few institutions in the sample are taking their first steps to address these risks in their decision-making processes, with significant differences across institutions.

ESG divisions are beginning to communicate and raise awareness on these topics at a high level within their institution. One large commercial banking group explicitly mentioned organizing an in-house training session on this topic with scientists and the top management (including risk divisions).

In terms of risk analysis, most of the sampled financial institutions have carried out partial and experimental analyses of physical climate risk in their portfolios in collaboration with external service providers. Three institutions in the French sample have been developing analyses at sectorial level with partial coverage in terms of sector and/or geography and/or type of physical climate risk. These early developments currently serve as risk pre-screening tools.

In the same vein, one large commercial banking group has begun integrating these risks in its sectorial policies, currently based on the same type of information used for pre-screening tools. Another large banking group is beginning to integrate these risks at the asset level for due diligence or into the ensuing monitoring process. The analysis is most mature for physical asset portfolios (e.g. real estate or infrastructure). Finally, three institutions in our sample have also started bottom-up exercises, where credit officers ask their counterparties about how they integrate physical climate risk into their process. This is organized as a first step towards understanding the type of information that counterparties could provide to help analyze these risks.

Financial institutions have expressed their views on some key dimensions to make physical climate risk information usable, specifically:

- Information should be transparent[6] and detailed in order to be able to discuss internally or with their counterparties' exposure and sensitivity to hazards.
- Data should ideally be granular enough to provide information that reflects the situation of their specific counterparties.
- In order to integrate decision-making, financial institutions need information to be reliable. Some of them suggest scientific advice on the relevant climate datasets to be used, but also external validation of a counterparty's information.
- Information that demonstrates materiality of this risk in their own horizons of analysis (mostly decadal, but also in the longer-term for strategic purposes) and that clarifies the range of uncertainties needed.
- Comparable information is important; the information can be better used in financial risk decision-making if it allows comparison between different counterparties in different sectors and geographies, and also if it compares exposure to physical climate risk with exposure to other types of risks.[7]

6 Transparency of information typically refers to clarity of the sources, of the methodology to carry out the analysis.
7 Some financial institutions also express preferences for some specific information formats. Some financial institutions are willing to be provided with some intermediary indicators in order to be able to combine them by themselves and produce tailored information. One expressed example of this need is to obtain sensitivity factors that are counterparty- and hazard-specific, that the financial institution will combine with its own selection of climate hazards scenarios.

Table 2 summarizes the most frequent types of needs that financial institutions mentioned during interviews carried out in France. The interviewees generally expressed the need for granular and asset- or counterparty-specific analysis.

Table 2. Investor approaches and information gaps – France

Aspect of risk decision-making	Specific user need	Way forward
Risk awareness	In-house understanding of physical climate risk: Building awareness among internal stakeholders about physical climate risks and their materiality to financial decisions.	• Training session or other training media. • Targets: top management, front office staff directly managing portfolios of counterparties.
Risk analysis	Framing risk assessment: need consensual guidance about what should be included in the risk analysis and what type of indicator would be relevant.	• Framework or general guidelines on physical climate risk analysis. • Key indicators to look at in different contexts.
	Risk pre-screening: identify material risks in a 'pre-screening' of risks. The perimeter (e.g. aspect of risk, type of hazard and portfolio) and granularity (e.g. regional and sectoral or local and specific) of the pre-screening is to be refined.	• Mapping of risks in portfolios and other alert tools.
	Finding climate data for risk assessment: need to have access to and knowledge of the relevant climate hazard datasets, so that financial institutions can carry out the analyses themselves or discuss third-party analyses.	• Climate datasets or guidelines on relevant climate datasets.
	Finding counterparty-specific data for risk assessment: as mentioned above on climate data, the same type of issues apply to counterparty-specific data.	• Exposure datasets along counterparty's value chain. • Check-list of relevant information to obtain from counterparties.
	Quantified and granular financial impacts: need to progress towards quantified indicators on financial impacts from physical climate risk, at counterparty-specific level.	• Methodology for quantification of financial impacts from physical climate risk at counterparty-specific level. • Transparent information on financial impacts to the counterparty.

Table 2. Investor approaches and information gaps – France		
Aspect of risk decision-making	Specific user need	Way forward
Risk management	Engagement with stakeholders: manage physical climate risk through engagement with counterparties.	• Check-list of relevant information to discuss risk exposure per type of asset/counterparty and hazard.

Source: Interviews conducted by I4CE in the context of ClimINVEST

Specific sector needs

Limited understanding of climate impacts has so far precluded prioritization of climate hazards

The interview process revealed a need for more knowledge about and a demand for further education on climate impacts in the banking sector as well as in other financial activities. It involves raising awareness among top management (including risks divisions) and front office staff who directly manages the portfolios.

Financial actors need more knowledge in order to be able to prioritize on the climate hazards they would need to analyse. Some financial actors still consider climate hazards to be long-term issue that applies more to developing countries, or believe that climate impacts only occur through direct exposure of physical assets. In several instances, climate hazards were identified in reference to well-known major flooding incidents from the Seine River, or to recent major heatwaves in Paris. This can be seen as an availability bias in the interview process.

SMEs and real estate appear to be a relevant focus in the banking sector

The banking actors consider portfolios of French SMEs to be a relevant focus area for physical climate risk analysis of retail banking activities. Most SMEs are non-listed companies with little information available from large public databases. Existing approaches on physical climate risk analysis currently do not address this aspect. They are also a good start to addressing the challenge of value chain identification. However, the banking actors also consider real estate portfolios to be a relevant focus area, since they represent a significant proportion of their activities, and exposure for such assets is easier to define. Thus, representing an opportunity to provide a complete risk analysis with available data, and to focus on refined analysis of climate hazards. Developments on both types of portfolios (i.e. real estate and credits to SMEs) are seen as relevant from the perspective of providing tangible pilot methodological frameworks for and results of risk analysis. Such developments should reveal to what extent it is currently possible to provide quantified analyses of financial impacts from climate change.

3.2 The Netherlands

Country-specific context: the Netherlands

The unique position of the Netherlands as a low-lying delta makes the country vulnerable to the physical impacts of climate change, such as sea level rise, increasing frequency and intensity of precipitation, and drought events. The largest climate-related risk in the Netherlands is flooding from, for example, sea level rise, river discharge, and/or heavy rainfall. These risks change over time, leading to costs in preventing and dealing with the impacts of floods. Although the probability of extreme flood events is low, the potential damages is substantial. Under different dike breach scenarios, damages are estimated at between EUR 20 and 60 billion (DNB, 2017 p. 24).

The financial implications of floods are endured by governments and those directly affected, who often are not, or only partly, compensated by the government. Actors in the financial sector holding assets in affected areas or in areas with increased flood risk may be directly affected as well. Indirectly, they may be hit when credit and investment portfolios are depreciated due to secondary effects. According to De Nederlandsche Bank (hereafter: DNB), future risk assessments should include both future climate change as well as government interventions that deal with flood risk. They are also advised to look for particular vulnerabilities in their portfolios. Currently, DNB does not foresee urgent financial destabilizing effects from the different flood scenarios (DNB, 2017).

The Dutch financial sector, including its supervisory authority (DNB), is active in different fora and networks to promote understanding of physical climate risk, and to discuss ways of dealing with it to reduce the financial consequences. Generally, the Dutch financial sector prefers an emphasis on possible solutions and opportunities, rather than on risks, creating a more positive perspective for dealing with climate change.

DNB is active in raising awareness and exploring the climate-related risks for the Dutch financial sector. In 2017, it released the report ‘Waterproof?’ - An exploration of climate-related risks for the Dutch financial sector’ (DNB, 2017). The report presents the implications of the physical consequences of climate change on Dutch insurers, investors and lenders. Insurers expect an increase in claims related to climate(change) as frequency of extreme weather events such as hail and rainfall is expected to increase and, consequently, lead to higher premiums. Insurance companies in the Netherlands are well aware of weather extremes but are less informed about long-term climate trends. They trust models provided by external parties that may not cover climate change trends for the Netherlands, even though they could prove critical for a thorough risk assessment.

DNB brings together different financial actors in working groups on sustainable finance. One working group (DNB, 2018) specifically focuses on climate-related risks, reflecting on integrating TCFD-style information into risk/return decisions-making. The DNB Sustainable Finance Platform’s Working Group on Climate Risk brought together different Dutch asset managers, banks and financial services companies. DNB is currently investigating ways to embed climate-related risks in its supervisory assessment framework. This is a challenging task, as not all risks are yet quantifiable and most risks have yet to crystallize (Elderson, 2018). In addition, DNB is developing both physical and transition-related stress tests which can help assess long-term risks faced by financial institutions. These includes a stress test on weather-related risks for Dutch general insurers, and development of a stress test on transition risks, exploring four future scenarios of policy and technology (Sleijpen, 2018).

User needs

Table 3 summarizes the user needs and way forward identified in the Netherlands. They reflect a range of different investor types (pension funds, asset managers, banks and central bank) and mandates for dealing with physical climate risk.

Table 3. Investor approaches and information gaps – the Netherlands

Aspect of risk decision-making	Specific user need	Way forward
Risk awareness	Improved understanding of physical climate risk and extreme events.	• Create an understanding of how climate change and extreme weather events will result in risks and opportunities for the built environment. • Create awareness about the materialization of relevant long-term risks and how these need to be mitigated in the short-term.
	Improved availability of knowledge about physical climate risk.	• Develop an overview of what is available, and specify what is relevant for loans and investments made by the banks in real estate or other sectors, and how to incorporate this into their investment strategy.
	Develop in-house understanding of physical climate risk.	• Anchoring of climate-related risk and opportunity competency at board level.
	Standardization of information.	• Work towards market standardization of relevant scenarios and data sources.
Risk analysis	Assessment of whether and how financial institutions incorporate climate-related risks in their decision-making process.	• Develop a more forward-looking approach to incorporating climate risks.
	Assessment of ways in which climate-related stress tests help in assessing the long-term risks that financial institutions face.	• Improve forward-looking risk management tools, such as scenario analysis and stress testing.
	Common taxonomy and economy-wide disclosure to consider climate-related risks on a company level basis.	• Create a common taxonomy and disclosure standard leading to climate-related risk obtaining its fair market price, and thereby also spur cost-effective adaptation measures.
	Information on physical impacts	• Develop a comparison tool between companies. • Create open source access. • For specific financial products, spatial levels and prioritization of risk management; for example for mortgage assessment, understanding what is important to focus on in terms of physical climate risk.

Table 3. Investor approaches and information gaps – the Netherlands		
Aspect of risk decision-making	Specific user need	Way forward
		• Integration of data on and analysis of climate-related risks into existing financial decision-making processes. • More research on ways in which climate change affects assumptions used in asset and liability management
	Scenario analyses; for example a risk/opportunity analysis with scenarios for the next 10-20 years.	• Detail the extent of future climate change, how will physical risks arising from climate-related damages change, especially at company level? What risks will company X face in sector Y over the next 10-20 years, and how can it adapt to these risks?
	Decision-useful metrics.	• Call on service providers to provide investors and lenders with decision-useful metrics on physical risks (including post 2050 risks). • Call on service providers to provide broader and more granular quantification of metrics.
Risk management	Creating awareness of the difference between passive and active management of investors.	• Sophistication of engagement tool. • Engagement with companies on sector – or individual level, with a passive or active investment strategies; for example a climate risk analysis also needs to work for a passive investment strategy.

Source: Based on a literature review and on conversations held by WENR and CAS in the context of ClimINVEST.

Specific sector needs – Built environment

DNB has specified the involvement of Dutch financial institutions in the built environment. For banks this includes: loans to households with their house as collateral in mortgages (a third of the cumulative balance); loans to commercial real estate companies; and company loans to other organizations with real estate as collateral (DNB, 2017).

Pension funds and insurers invest in mortgage loans and real estate investments, where the latter include both direct investments in real estate (i.e. ownership of buildings) and investments through real estate funds. DNB has listed the size of loans and investments in residential, commercial and business real estate by Dutch financial institutions in the Netherlands and abroad in the 'Waterproof' report. Dutch banks have invested EUR 54 billion, pension funds EUR 22 billion, and insurers EUR 11 billion in commercial real estate (DNB, 2017). In the Netherlands, at the end of 2016, approximately EUR 22 billion of Dutch commercial real estate was under the proprietorship of foreign investors. The most prominent foreign investors for Dutch real estate are from Germany, Belgium, the United States, France and Switzerland (Klapwijk et al. 2017).

Specific needs raised by different financial actors include a need for a climate risk scan linked to the mortgage lender value (the value of a building in the future) which is important information for banks and real estate appraisers during the due diligence phase. Providing insight into the climate risks could result in lower insurance premium. In addition, there is a need to explore existing tools and datasets for climate risk assessment, with a specific emphasis on incorporating future climate

scenarios (e.g. mid-century, for different climate scenarios). And to identify which physical climate risks are relevant, analyze which datasets and indicators are available that can be extrapolated to the future. The way foreign investors consider climate risks in the Netherlands may differ significantly from domestic investors, who are well accustomed to the country's long history of dealing with water. The Dutch Climate Impact Atlas provides insights in climate change impacts in the Netherlands for international investors interested in investing in the Netherlands.[8]

8 The Atlas provides information on climate impacts related to flooding, waterlogging, drought and heat in the Netherlands, see www.klimaateffectatlas.nl.

3.3 Norway

Country-specific context: Norway

Physical climate risk is now clearly on the agenda of the Norwegian financial sector (Norwegian Ministry of Finance, 2018). Institutions are building capacity through sustainability teams and Environmental, Social and Governance (ESG) integration processes. Flooding and heavy precipitation are of immediate concern to investors in Norway and other Nordic countries, as highlighted in CICERO's report on flood risk for investors (CICERO, 2018a and 2018b).

The Norwegian government has been active in raising awareness of climate change, including physical climate risk. In October 2017, the Norwegian government appointed an expert commission «Klimarisikoutvalget» to look at climate-related risks, and their potential impacts for the Norwegian economy, which includes physical climate risks. The commission is chaired by Martin Skancke, member of the CICERO Advisory Board on Climate Finance and Chair of the UN Principles of Responsible Investment. The report was published mid-December 2018 (Norwegian Ministry of Finance, 2018), and highlights the need for further analysis of physical climate risk within Norway, but also of physical impacts outside the country that can impact Norway's economy, for example via trade patterns and resource pricing. The Ministry of Finance reports annually to Norges Bank, Norway's central bank, on the financial stability and financial market in Norway, for the Norwegian Central Bank. These reports include climate-related risk, in broad terms, and linkage to the TCFD recommendations and reporting.

By virtue of its ownership role, the Norwegian government sets expectations regarding climate-related risk. The government owns the sovereign wealth fund, managed by Norges Bank Investment Management (NBIM), and owns shares of the Norwegian bank DNB. The government expects the companies in which it owns shares to: (i) have a sound understanding of the risk posed to their activities by climate change and climate policy measures; (ii) be at the forefront of climate and environmental performance in their sector including initiatives to reduce greenhouse gas emissions; and (iii) be well-informed of the benefits to be reaped from early adaptation to a warmer climate (NBIM, 2018).

A roadmap for green competitiveness outlines pathways to climate change in the financial sector, published by the financial industry organization Finance Norway (Finance Norway, 2018). The roadmap states that climate change has significant economic, physical and regulatory implications for the Norwegian business sector. It provides seven recommendations regarding climate-related risk, among them: aligning climate reporting with the recommendations of the TCFD; increasing climate competence and capacity in the financial sector; and including climate-related risk in the supervisory authority's mandate.

Norwegian banks indicate that prioritization of risks and opportunities is influenced by feedback from stakeholders, strategic platforms, global development trends, support for global initiatives, and by international standards and requirements imposed by the authorities. These are incorporated into GRI frameworks and materiality analyses. Climate change is an important risk and opportunity driver in long-term strategic thinking, including for group and industry sector business strategies. The Norwegian government has documented expectations on climate change for the Norwegian financial institutions in the white paper Meld.St.27 (2013-14) Diverse and value-creating ownership (Norwegian Ministry of Trade, Industry and Fisheries, 2013).

User needs

The results presented in Table 4 reflect a range of different investor types (pension funds, asset managers, and banks) and mandates on dealing with physical climate risk. The most common information gap cited was a lack of consistent company-level data on climate-related risks such as scenario and planning information and links between climate risks and company financials. For physical impacts specifically, information gaps were noted on company-level water-related risks and granular information on water stress areas.

Table 4. Investor approaches and information gaps – Norway

Aspect of risk decision-making	Specific user need (based on survey results from CICERO Climate Finance Advisory Board[9] + Wallenberg project[10])	Way forward
Risk awareness	Information on sustainability.	• Clarify interpretation and scope. • Clarify relations to ESG, SRI information. • Analyze limitations and trade-offs across SDGs.
	Improved understanding of climate-related risks.	• Build company capacity in terms of personnel, structure, and processes. • Offer climate risk courses and training material.
	Standardization of information.	• Collaborate across climate information providers to provide publicly available comparison tools.
	More comprehensive and detailed climate change information, with information on which sources are credible.	• Further research and analysis. • Communication of credible information sources.
Risk analysis	Information on physical impacts such as assessment of impact of climate change on real estate portfolios.	• Further research and analysis to develop more detailed data, with less uncertainty, including asset-level data such as company level water-related risks. • Research on insurance coverage of climate risk. • Third-party assessments on physical impacts of assets.
	Scenario analyses such as risk/opportunity analysis with scenarios for next 10-15 years	• Improve transparency, especially regarding assumptions and guidance on which scenarios to use. • Communicate information in terms of a 10-15 year time horizon.

9 See list of Advisory Board members here: http://www.cicero.uio.no/en/cicero-climate-finance/advisory-board - note that the table excludes input from the non-Nordic members of the Advisory Board.

10 The Wallenberg project is funded by the Wallenberg foundation, carried out by Stockholm Environment Institute and CICERO, to investigate how climate risk information for financial markets can be improved, and the motivations for investing in green bonds.

Table 4. Investor approaches and information gaps – Norway		
Aspect of risk decision-making	Specific user need (based on survey results from CICERO Climate Finance Advisory Board[9] + Wallenberg project[10])	Way forward
		• Improve capacity to use scenario information, with detail on scenario sector/company/country impacts.
	Climate change indicators.	• Collaborative development of relevant indicators for extreme events associated with climate change. • Improve disclosure on indicators by companies.
	Standards.	• Research and collaboration to establish standards for climate-related risk information and stress-testing.
Risk management	Avoid high-risk investments and reduce high-risk activities.	• Assess physical climate risk of different activities.
	Collect information on most promising technologies for improving resilience and climate robustness.	• Research to support preparedness for future climate change by building resilience to reduce risk. • Focus on resilience as a business opportunity.
	Reduce risk through distributing activity over different locations and sectors/technologies.	• Provide information on sectors/companies/regions and relative exposure to climate risk.
	Assess robustness and preparedness of a company.	• Develop screening tools to assess a company's: • Capacity to evolve • Flexibility • Business model viability • Long-term perspectives • Support disclosure of these aspects in company reporting

* Norwegian institutions, plus one Swedish financial institution
Source: CICERO, 2017. Shades of Climate Risk report [based on CICERO survey conducted among the financial stakeholders on the Advisory Board of CICERO Climate Finance]

User needs – Flooding and extreme events

Norway, as elsewhere in northern Europe, is already experiencing increased precipitation and flooding associated with climate change. Extreme events can exacerbate the amount of precipitation that falls on rainy days. Regular flooding events are also a concern when storm water systems are unable to cope with the amount of rainfall.

Investors and climate researchers gathered together at the Ny Ålesund Symposium 2018 held in Svalbard in the Arctic to collaborate on navigating climate-related risk. The discussions focused on extreme events, climate scenarios, and green bonds. Climate researchers highlighted that we can expect more extreme events as experienced, for instance, in the summer of 2018, with intense hurricanes, heat waves and resulting forest fires. Changes in jet stream patterns could further complicate extreme events. Discussions revealed the need for rethinking the best indicators to assess the potential impacts of extreme events on financial systems. Further, climate models may underestimate the changing patterns of extreme events. There are observations and model projections for physical climate impacts could be better communicated by researchers, with greater transparency on uncertainty (Ny Ålesund Symposium Summary, 2018).

4 User needs synthesis

Key points:

- **Need for in-house capacity building and training within financial institutions on physical climate risk to increase risk awareness.**
- **Need for better tools and metrics to assess how the climate changes, including increases in flooding and extreme weather events, and associated physical impacts that affect assets in specific sectors, markets and locations.**
- **Need for guidance and information to better engage with companies on climate-related risks.**

This report provides a synthesis of financial sector needs regarding physical climate risk categorized as risk awareness, risk analysis and risk management. More specifically, we focus on investors information needs for developing and improving understanding of physical impacts of climate change, for qualitative and/or quantitative estimation of physical climate risks and for identifying and implementing plans, actions or strategies to reduce the implications of these risks. We reflect on the needs of a range of different investor types (pension funds, asset managers, insurance, and banks) across France, the Netherlands and Norway. Note that this synthesis is based on inputs gained in the first stage of the ClimINVEST project and does not provide a complete picture of all user needs amongst all different investor types. This user needs synthesis will be further updated during the project.

Risk awareness

- Introduction to physical climate risk, i.e. need for basic information that can be shared and tailored for in-house use within financial institutions, for both sustainability and risk managers.
- To know what information is available in the public sphere, what is reliable and how to use it.
- Need for clearer communication on the value creation of climate change opportunities in reducing risk.

Risk analysis

- Data on various climate scenarios and how these will impact sectors, companies, countries and equity markets.
- Information that demonstrates materiality of physical climate risk, identifying cross-sectoral indicators and geographical approaches.
- Assessment of insurance gaps, i.e. information on physical climate risk that are not covered by insurance.

- Information on how climate change, and extreme events will result in risks and opportunities for the built environment, which may affect bank-mortgage lenders as well as other sectors.
- Need for a more short-term focus on the impacts of climate change (i.e. next 10-20 years) relevant for companies and banks. This is also relevant for risk analysis within 10 years and for strategical analyses beyond 15 years.
- Need for guidance from researchers on which physical impacts and indicators could be important with relevant spatial detail, with a specific focus on extreme events and water-related risks.
- Need for mapping of physical climate risk to an asset level.

Risk management

- Need for guidance on engagement, for example a checklist of physical climate risk to engage with companies.
- Need for clear information from researchers on uncertainty related to the probability of physical impacts of climate change.

5 Way forward from user needs to co-designing tools

The user needs identified in this synthesis underscore the need for collaborative efforts between research and finance on improving climate information for risk assessment. Specific ways that the ClimINVEST project will support the way forward include:

- Risk awareness: building capacity on climate-related risk through tailored courses and training materials;
- Risk analysis: co-designing information on relevant indicators for climate change and associated physical climate impacts in the next 10-15 years;
- Risk management: developing guidance on how to engage with companies.

The ClimINVEST project convenes a meeting space between climate change researchers and financial decision-makers along the impact chain from climate hazards to physical impacts to financial impacts, to facilitate investor's decision-making on climate-proof investments and build public understanding of climate-related risks.

***Impact chain** from climate hazards to financial impacts*

In its next phase, the ClimINVEST project team collaborates with financial institutions in France, the Netherlands and Norway in a series of science-practice labs to co-design transparent and publicly available information and methodologies based on open-access data. Based on this synthesis reports, the first round of ClimINVEST science-practice labs will focus on:

- Bank lending to SMEs in France;
- Built environment in the Netherlands;
- Extreme events/flooding in Norway.

If you, as a financial actor, are interested in joining one of the science-practice labs or in collaborating with us on emerging issues dealing with physical climate risk, please contact us:

- France – Romain Hubert – romain.hubert@i4ce.org
- The Netherlands – Karianne de Bruin – karianne.debruin@wur.nl
- Norway – Sophie Dejonckheere – sophie.dejonckheere@cicero.oslo.no

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Acronyms

DNB – De Nederlandsche Bank (the Dutch central bank)

ESG – Environmental, Social and Governance criteria

NBIM – Norges Bank Investment Management

NGFS – Central Banks and Supervisors Network for Greening the Financial System

SME – Small and medium-sized enterprises

TCFD – Task Force on Climate-related Financial Disclosures

CICERO is Norway's foremost institute for interdisciplinary climate research. We help to solve the climate problem and strengthen international climate cooperation by predicting and responding to society's climate challenges through research and dissemination of a high international standard.

CICERO has garnered attention for its research on the effects of manmade emissions on the climate, society's response to climate change, and the formulation of international agreements. We have played an active role in the IPCC since 1995 and eleven of our scientists contributed the IPCC's Fifth Assessment Report.

- We deliver important contributions to the design of international agreements, most notably under the UNFCCC, on topics such as burden sharing, and on how different climate gases affect the climate and emissions trading.
- We help design effective climate policies and study how different measures should be designed to reach climate goals.
- We house some of the world's foremost researchers in atmospheric chemistry and we are at the forefront in understanding how greenhouse gas emissions alter Earth's temperature.
- We help local communities and municipalities in Norway and abroad adapt to climate change and in making the green transition to a low carbon society.
- We help key stakeholders understand how they can reduce the climate footprint of food production and food waste, and the socioeconomic benefits of reducing deforestation and forest degradation.
- We have long experience in studying effective measures and strategies for sustainable energy production, feasible renewable policies and the power sector in Europe, and how a changing climate affects global energy production.
- We are the world's largest provider of second opinions on green bonds, and help international development banks, municipalities, export organisations and private companies throughout the world make green investments.
- We are an internationally recognised driving force for innovative climate communication, and are in constant dialogue about the responses to climate change with governments, civil society and private companies.

CICERO was founded by Prime Minister Syse in 1990 after initiative from his predecessor, Gro Harlem Brundtland. CICERO's Director is Kristin Halvorsen, former Finance Minister (2005-2009) and Education Minister (2009-2013). Jens Ulltveit-Moe, CEO of the industrial investment company UMOE is the chair of CICERO's Board of Directors. We are located in the Oslo Science Park, adjacent to the campus of the University of Oslo.

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