

# The stakeholders of trans-boundary climate risk management

A case study

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## List of Abbreviations

<b>ADPC</b>	Asian Disaster Preparedness Center
<b>AHK</b>	German foreign chambers of commerce
<b>ARC</b>	African Risk Capacity
<b>BMU</b>	(Former) German Federal Ministry for Environment and Nuclear Safety; now (Former) German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
<b>BMWi</b>	Former German Federal Ministry for Economic Affairs and Energy; now: German Federal Ministry for Economic Affairs and Climate Action
<b>CCRIF</b>	Caribbean Catastrophe Risk Insurance Facility
<b>CLIC</b>	Climate Impact Chains in a Globalized World: a Challenge for Germany
<b>DLR</b>	German Aerospace Center
<b>DRR</b>	Disaster risk reduction
<b>GERICS</b>	Climate Service Center Germany
<b>GIDRM</b>	Global Initiative on Disaster Risk Management
<b>GIIF</b>	Global Index Insurance Facility
<b>GRiF</b>	Global Risk Financing Facility
<b>GIZ</b>	German Corporation for International Cooperation GmbH
<b>IHK</b>	German chambers of industry and commerce
<b>IMMA</b>	Inter-ministerial working group on adaptation
<b>ISF</b>	InsuResilience Solutions Fund
<b>NFRD</b>	Non-Financial Reporting Directive
<b>PIK</b>	Potsdam Institute for Climate Change Impact Research
<b>PPP</b>	Purchasing Power Parities
<b>REE</b>	Rare-earth elements
<b>SMEs</b>	Small and medium enterprises
<b>TCFD</b>	Task Force on Climate-Related Financial Disclosures



# 1 Introduction

## 1.1 Background

This case study is part of the CLIC project, Climate Impact Chains in a Globalized World: a Challenge for Germany, financed by the German Federal Ministry of Education and Research (BMBF). CLIC focuses on transboundary climate impacts that affect trade and production activities of the German economy.

Previous and ongoing CLIC case studies investigate the vulnerability of international supply chains of the German economy, taking as examples the cocoa industry, the grape juice industry and the wood industry. Jointly with the literature review by Osberghaus (2019), the studies see an impact of extreme weather events on the export of manufactured and agricultural products in vulnerable countries. At the same time, the studies show that German trade flows are mainly affected in cases of high dependency on one country of supply.

In this context, the present case study seeks to investigate the degree transboundary climate risks are currently being addressed by the German real economy. Using a stakeholder analyses approach, the study identifies relevant actors from the German economy, financial sector and government, among others. It then looks at their perceptions on transboundary climate risks as well as their present and potential role in implementing or supporting climate risk management. The case study thereby wants to point out opportunities for the German real economy that arise from an engagement of stakeholders.

## 1.2 Methodology

The case study is based on the previous findings of CLIC as well as other relevant and recent literature on climate-related risks. It is complemented by interviews with representatives from various stakeholders comprising the German industry, finance, commerce and international (development) cooperation. The list of interviews conducted is presented as Annex I under Chapter 5.

A stakeholder analysis approach from transdisciplinary research was used as a methodological basis for the case study. Lelea et al. describe the latter as “finding solutions to ‘real world’ problems and challenges, and [...] increasing relevance of the ‘academy’ to ‘the real world’” (2014: 1). The case study follows a similar objective, as it looks at the adoption and application of a more research-based climate risk approach within the strategic and operational risk management of the real economy.

For the identification of relevant stakeholders, the case study considers actors who have a certain interest and/or who play a certain role in regard to the issue of transboundary climate risk management. Based on Lelea et al. (2014) the stakeholder analysis looks at the aspects presented under Figure 1.

4 Stakeholder analysis		
Who has a 'stake' with regard to the problem/issue and why?	Who has power, interest, knowledge, resources...?	What are the relationships between stakeholders?

**Figure 1: Stakeholder analysis (Lelea et al. 2014, section)**

The stakeholder analysis concentrates on German stakeholders, referring to actors from the private and public sector, as opposed to individuals. This focus defines the boundaries of the analysis, while it also provides a better understanding of relationships and interdependencies between stakeholders within a system. In the end, it can also facilitate the management of stakeholders, e.g. by political actors starting to engage in transboundary climate risk management.

Stakeholders were identified based on previous CLIC contacts, combined with an internet research as well as a snowball approach receiving additional contacts from interviewees and other individuals. Based on the inputs from these sources, a number of stakeholders could be determined, without being exhaustive. The following table comprises six general stakeholder groups with eight individual stakeholders identified for this case study:

**Table 1: Identified general stakeholder groups and individual stakeholders**

Stakeholder group	Stakeholders identified
German metal industry:	WV Metalle
Federal Ministry for Economic Affairs and Energy (BMWi):	Department IVC3 – Coordination of the national climate policy
(Re)Insurance companies:	MunichRe
International development cooperation:	GIZ: InsuResilience Secretariate GIZ: Global Initiative on Disaster Risk Management (GIDRM)
Chambers of commerce:	IHK Bremen AHK: German-Thai Chamber of Commerce
Climate service providers:	Climate Service Center Germany (GERICS)

For each of the stakeholders semi-structured interviews were conducted with representatives, having a focus on 1) their perceptions regarding the relevance of the subject for their field of work; 2) planned or existing activities in this context and 3) needs and barriers to further develop the overall engagement of stakeholders in transboundary risk management.

### 1.3 Structure

The document, following this introduction, contains a main chapter with the stakeholder analysis. It presents the results of the literature review and from interviews, starting with an overview on transboundary climate risks. It then focuses on the analyses of the German metal industry, looking at climate risk awareness and risk management strategies. The subsequent Chapter 2.3 on supporting stakeholders is structured according to the main stakeholder groups: 1) the German metal industry; 2) the BMWi; 3) trade associations and chambers of commerce; 4) (re)insurance companies; 5) the international (development) cooperation and 6) climate service providers. The overall Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** provides insights into needs and perceptions of the identified stakeholders regarding transboundary climate risk management in international trade. Furthermore, it looks at already existing risk management strategies and measures, as well as barriers and limitations for companies and organisations. Finally, Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** presents conclusions on the main findings of the analysis, including a stakeholder map together with recommendations on further research and action.



## 2 Analysis of stakeholders in transboundary climate risk management

### 2.1 Transboundary climate risks

The impacts of climate change primarily have a regional or local dimension, when looking e.g. at the occurrence and trends of extreme weather events and at risk factors such as exposure and vulnerability. However, climate change impacts also have an international dimension. In their final report on the global impacts of climate change for Germany, Peter et al. describe that impacts “spread beyond political borders due to the global physical and economic interconnectedness” (Peter et al. 2020: 6). They argue that particularly countries with highly globalised economies can be affected by transboundary impacts of climate change. Peter et al. conclude that for the German economy the impacts of climate change through international trade are at least as significant as the impacts within national borders.

Trade in vulnerable export and import countries can be affected through weather variations and extreme weather events in different ways. Oberhausen (2018) names the destruction of transport infrastructure and the disruption of production processes in the agricultural and manufacturing sector. Both have potential negative consequences on (international) supply chains. For imports, Oberhausen argues that the income in vulnerable countries can be affected by weather extremes and thereby the demand for goods may decrease.

The “Concept of risk in the IPCC Sixth Assessment Report” (Reisinger et al. 2020) describes climate risk as the potential for adverse consequences from climate change impacts for human or ecological systems. This definition refers to physical climate risks that “result from dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards” (Reisinger et al. 2020: 5). Climate risk can however also refer to human responses to climate change. A more detailed explanation is provided below under transition risk.

The German Federal Ministry for Environment and Nuclear Safety (BMU) recently published the national climate impact and risk assessment. In its sector report on economy and health, Wolf et al. (2021) conclude that German imports of raw materials and intermediary products are facing medium climate risks and will continue to do so under an optimistic climate change scenario. For exports and international transport of goods, risks are currently low with the same prediction until 2060 under the optimistic scenario. This is further reflected in the study by Peter et al. (2019) on transnational impacts of climate change for Germany. They also look at opportunities for German international trade in the context of climate change, which they find to be more related to exports, as presented in Figure 2.

#### IMPORTS

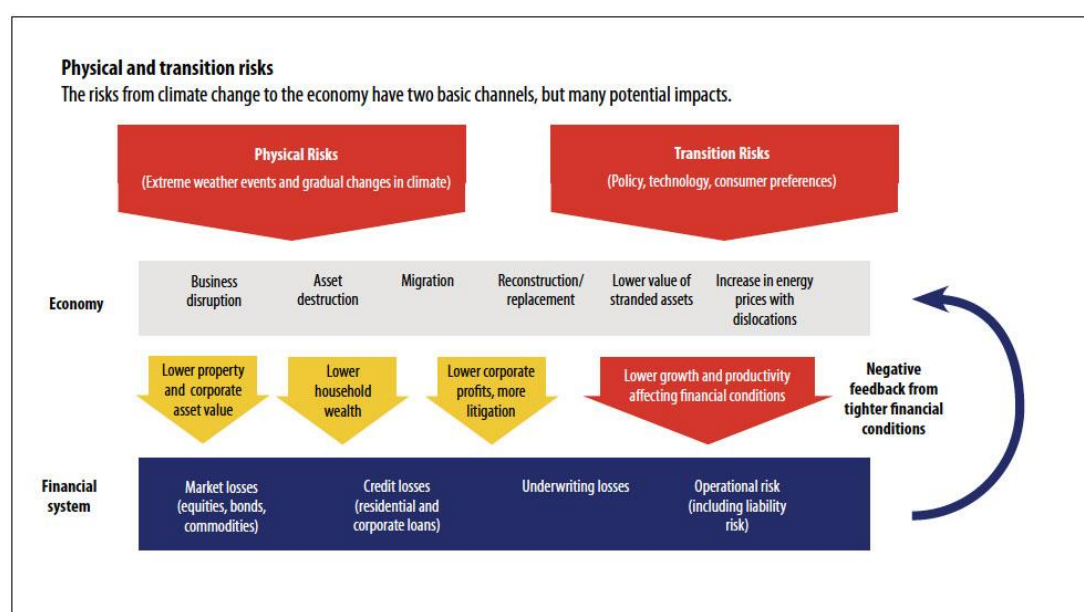
	No risk	Low risk	Medium risk	High risk
Opportunities <b>High</b>				
Opportunities <b>Medium</b>			Energy sources	Shipping traffic, Agricultural products
Opportunities <b>Low</b>		Tourism	Forestry systems	
None Opportunities	Livestock	Road transport, Aquatic systems	Infrastructure, Construction & raw materials, Labour force, Air traffic, Rail traffic	Buildings, production facilities, warehouses

**EXPORTS**

	No risk	Low risk	Medium risk	High risk
Opportunities <b>High</b>	Investments, Climate adaptation			Climate-friendly consumer goods
Opportunities <b>Medium</b>		Preferences for foods		Investments, Climate change mitigation
Opportunities <b>Low</b>		Consumer preferences, Insurance services, Other services	Financial services	
None Opportunities				Economic growth, Purchasing power, consumption

**Figure 2: Risks and opportunities of imports and exports (Peter et al. 2019, modified by adelphi)**

These opportunities together with the main risks identified for German exports are related to the transition of markets as a response to climate change, related policies, as well as consumer preferences. An example are climate-friendly consumer goods that are both a risk and an opportunity. In some cases, the rapid development and change in technologies may lead to a collapse of specific branches of industry. In other cases, these changes have a potential for new investment opportunities and the emergence of new branches. Accordingly, the transition to low-carbon economies poses a high risk for industries not capable to adjust in time (TCFD 2017). An overview on physical and transition risks is provided under Figure 3.



**Figure 3: Physical and transition risks (Grippa et al. 2019)**

The subject of transition risks (and opportunities) has gained momentum in recent years in the international financial and economic sector. This has a direct impact on the real economy through investment and reporting requirements. The Task Force on Climate-Related Financial Disclosures (TCFD), established by the Financial Stability Board in 2015, is a major international driver in this process. The TCFD has set recommendations and a reporting framework in order to make companies' climate-related disclosures more consistent and contribute to more transparency and stability of the international market. While the TCFD also addresses physical risks of climate change, there is a focus on legal liabilities as well as

transition risks. Major companies, such as the DAX 30, now report on a regular basis following the TCFD framework.

While climate-related risks refer to both physical and transition risks jointly, the literature review and interviews of this analyses have shown that particularly in the financial sector this term currently has a stronger emphasis on the transition to a carbon neutral economy. Nevertheless, this case study has a stronger focus on perceptions and action by different stakeholders in regard to physical climate risks in international trade, particularly looking at supply chains of the German economy.

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## **2.2 Risk awareness of the German industry**

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### **2.2.1 General observations**

The present analysis provides a glance but not a full picture of the German industry, considering that interviews were only conducted with representatives from an association without any direct voices from companies. At the same time, findings from all interviews, CLIC case studies and other literature are able to give a general idea on climate risk awareness and management of Germany's international trade.

While the degree of climate risk awareness in the private sector depends on various factors, major global companies already report on climate risks in their supply chains, some having risk management systems in place and insuring risks such as shortfalls in production or transport (Rauch, 19/04/2021). Nevertheless, the general observation, also shared by Loew et al. (2021), is that transboundary climate risks mostly remain unaddressed by the German industry and businesses. One reason, according to Rauch from MunichRe, is that many companies are still not aware about climate risks in their supply chains and potential impacts on their business (Rauch, 19/04/2021). Although he observes that overall awareness has been increasing in the past decade, this is rather considered the case for large companies with a global business. An obstacle for small and medium enterprises (SMEs) can be the limited knowledge and access to climate data, as well as a lack of information on their entire supply chain. Even having this information, the possibilities of SMEs to address certain risks are limited. This regards their leverage on supply chains as well as capacities to establish a risk management system. Furthermore, they may not have sufficient resources to insure against risks in their supply chains. (Rauch, 19/04/2021).

Finally, the interviewee points out that international financial markets and thus also economies behind them, experience a shift of priorities concerning climate risks. This takes place from medium to long-term physical risks of climate change towards short to medium-term risks of liability and rapidly transitioning markets (see Section 2.3.2).

When looking at the case of Thailand, where the 2011 floods in and around Bangkok created worldwide attention and awareness in regard to the vulnerability of international supply chains, the current picture is mixed. Some international companies such as Isuzu reacted after the floods by increasing their risk management (Begerow and Bentfeld 06/05/21), while other companies do not seem to have developed any strategies or measures in response. Particularly companies that entered the market more recently appear to have limited awareness of the local climate risks – at least it is not a relevant topic for companies that have been in contact with the German Chamber of Commerce in recent years (see Section 2.3.1).

These impressions correlate with recent research results from the German Environmental Agency (Umweltbundesamt) that climate risks and their management in international trade do not receive high attention from the German industry and business sector (Loew et al. 2021). The following section will use the example of the German metal industry in order to understand

potential climate risks along the supply chain, perceptions of the sector and general risk management strategies.

### 2.2.2 Case of the German metal industry

The metal industry has a high economic value for Germany. Information provided by the Federal Ministry for Economic Affairs and Energy (BMWi 2021) indicates that the steel producing industry generates a turnover of 32.8 billion Euro (2019) and the non-iron producing industry 52.4 billion Euro (2018). It also shows that Germany ranks as the 7<sup>th</sup> largest producer of steel products and the largest producer of non-iron products globally. Exports range up to 47% for non-iron products (mainly within Europe) and for steel mill products imports largely balanced out the exports of 27.8 million tonnes in 2018 (from a total production of 36.6 million tonnes). The metal processing industry generates another 80 billion Euro annually, consisting of over 5,000 companies with approximately 500,000 employees (WSM 2021), thus contributing to the overall importance of this sector for the German economy.

Raw materials, i.e. ferrous and non-ferrous minerals, are almost completely imported by the German metal industry and the largest producing countries are located outside the EU. The main countries producing iron ore are Australia, Brazil, China and India (Statista 2021a). Looking at non-ferrous minerals, bauxite is one of the most relevant ones, used for the production of aluminium. Its main countries of origin are Australia, Guinea and China (Statista 2021b). For rare-earth metals (also REE for rare-earth elements) the market so far is dominated by China, responsible for 70.6 % of global production in 2018 (Kirsch 2019). According to Strafor (2019), over half of China's production originates from one mine in Mongolia and the country's own demand is increasing so that the reliability of global supplies is considered critical. In response to this dependency from China and the high demand for REEs, more and more countries such as the USA and Brazil are increasing their production. However, extraction processes are complex and environmentally challenging, thus hindering the extraction at large scale. Considering the general dependency of the German metal industry on imports of metallic minerals and the specific countries of origin, the question arises to what degree supply chains are also affected by the impacts of climate change.

For this analysis, representatives from the German non-ferrous metal industry provided input through the sector association WV Metalle, counting 649 member companies. Asked about general climatic impacts on mineral extraction, Niese and Hackert (21/04/2021) state that weather and weather extremes regularly affect extraction in the countries of origin, e.g. through heavy rains and landslides hindering the works at open pit mines that are the most common way of extraction. According to the interviewees, this is perceived as "daily business" (Niese and Hackert 21/04/2021) by the sector and no particularly higher risks are being observed by the industry during the past years and decades that they would attribute to the impacts of climate change. In regard to the dependency of mineral supplies, the picture provided by the interviewees is twofold: On the one side, they argue that for metals like aluminium there is a high international supply, with deposits all over the world. Therefore, the industry has a low dependency in regard to the location as well as suppliers. On the other side, the state that for some REEs the dependency on a few locations is high and that this often comes combined with a large competition on the market due to an increased demand for modern technologies. However, the perception of the WV Metalle representatives is that social, political and environmental aspects are a higher obstacle in this context rather than climatic impacts. Additionally, they state that the recent German legislation on sustainable supply chains poses a new challenge and is currently a priority for the industry, considering that other major players such as Russia and China do not follow these standards.

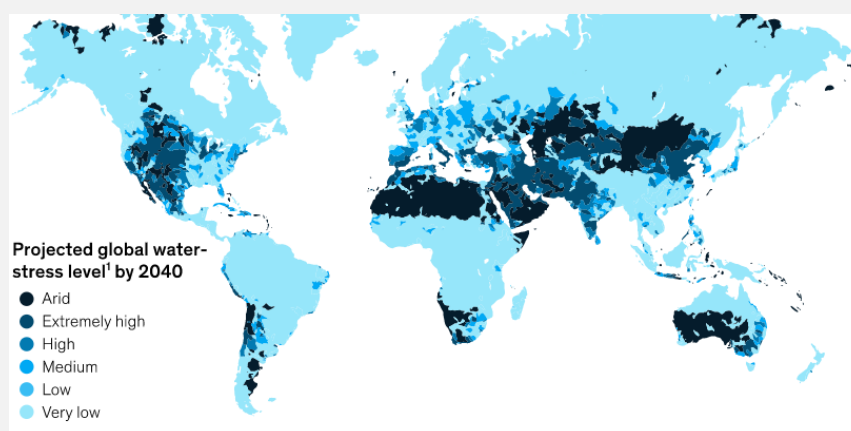
When looking at studies regarding the impacts of climate change on metal extraction and trade a more complex picture is presented. Alongside the climate related increased risks of flooding and landslides due to extreme rainfall events, Bebbington et al. (2015) also point out the

relationship between the mining industry's demand for water and the increased risks of drought as well as storm events, the latter threatening the failure of dams and mine infrastructure.

### The vulnerability of metal ore supplies

Within the research project “ImpactCHAIN”, Peter et al. (2019) identified vulnerable countries with a high relevance for German imports. Among the highly vulnerable countries are Brazil and India – both relevant for metal ore supplies to Germany. Another research project called “KlimRess” looked at the vulnerability of producing countries based on the ND-GAIN<sup>1</sup> index and highlighted that the main countries of German supplies for tin, bauxite, copper and iron are located in highly vulnerable countries (Rüttinger et al. 2020). Nevertheless, as part of the recent climate impact and risk assessment for Germany, Wolf et al. (2021) found that the weighted vulnerability of the overall metal ore supply is relatively low compared to other raw materials. At the same time the study points out the significant import volume that may become a risk should supplies fail.

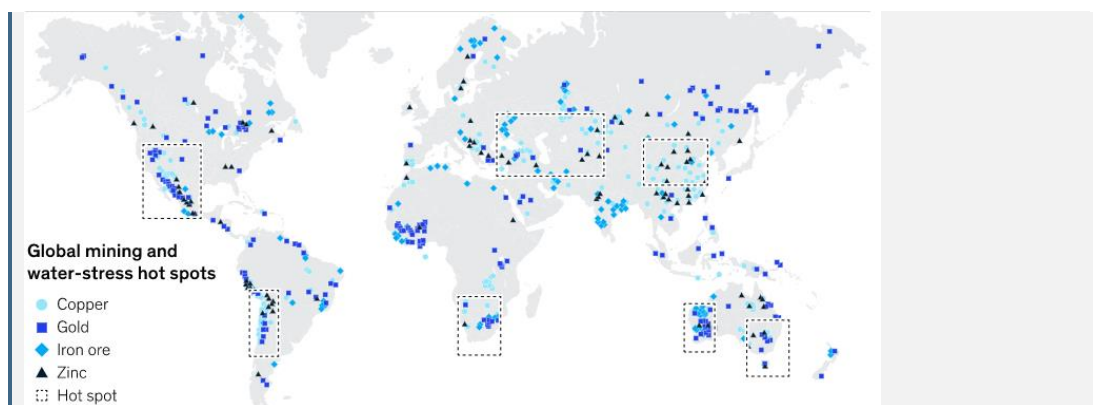
Globally, 30 to 50 percent of copper, gold, iron ore, and zinc mines are located in regions with high water stress (Henderson and Maksimainen 2020). Especially for water-intense mining processes, drought events and declining groundwater levels can lead to a failure in production. On the other side, companies may face increasing difficulties in obtaining licenses for mining in semi-arid and arid regions. Delevingne et al. (2020) identified the following water-stress hot spots for mining until 2040<sup>2</sup>: Central Asia, the Chilean coast, eastern Australia, the Middle East, southern Africa, western Australia, and western North America (see Figure 4).



<sup>1</sup> The ND-GAIN index measures the comparative resilience of a country based on a quantification of its readiness to mobilise investment for adaptation (9 indicators) and its vulnerability to disruptive climate events (36 indicators) (Chen, Noble, I. et al. 2015).

<sup>2</sup> Based on a climate change scenario with a rise of the global mean temperature by 2.8°C to 4.8°C.





**Figure 4: Global mining and water-stress hot spots (Delevingne et al. 2020)**

Delevingne et al. (2020) also emphasize the risks related to extreme rainfall and flood events, including the closure of open-pit mines, destruction of access roads and instability of tailing dams. While the temporary disruption of operation due to heavy rains is not uncommon for open-pit mines, as pointed out by Niese and Hackert (21/04/2021), extreme weather events are likely to increase regionally under different climate change scenarios. Using their “business-as-usual scenario”, Delevingne et al. describe six “wet spots” with a potential increase in extreme precipitation by 50 to 60 percent within this century. For the Southern Hemisphere summer, these are northern Australia, South America and southern Africa, while for the southern hemisphere winter they comprise central and western Africa, India and Southeast Asia, and Indonesia. Delevingne et al. also identified the highest flood risk for the production of iron ore and zinc, with 50 percent and 40 percent of global volumes potentially affected.

The information provided in the textbox largely demonstrates increasing climate-related risks for mining at a global scale. However, data presented for Germany underpin some of the main messages from WV Metal that existing and potential future climate risks don’t seem to have a major impact on the supply chains of the German metal industry yet.

Imports of bauxite, tin and REEs from highly vulnerable countries may currently face higher risks in their supply through local social and political conditions. Guinea is an example, where Human Rights Watch reported the violation of a series of human rights by mining companies (Human Rights Watch 2018). Access to and negative impacts on land, water, health and the environment are described amongst those violations having a high impact on the current living conditions of the local population. At the same time, it should be considered that these violations also affect the population’s and country’s overall climate vulnerability. The lack of water is already reported as a significant social problem and it might also become a problem for the industry itself, as pointed out before.

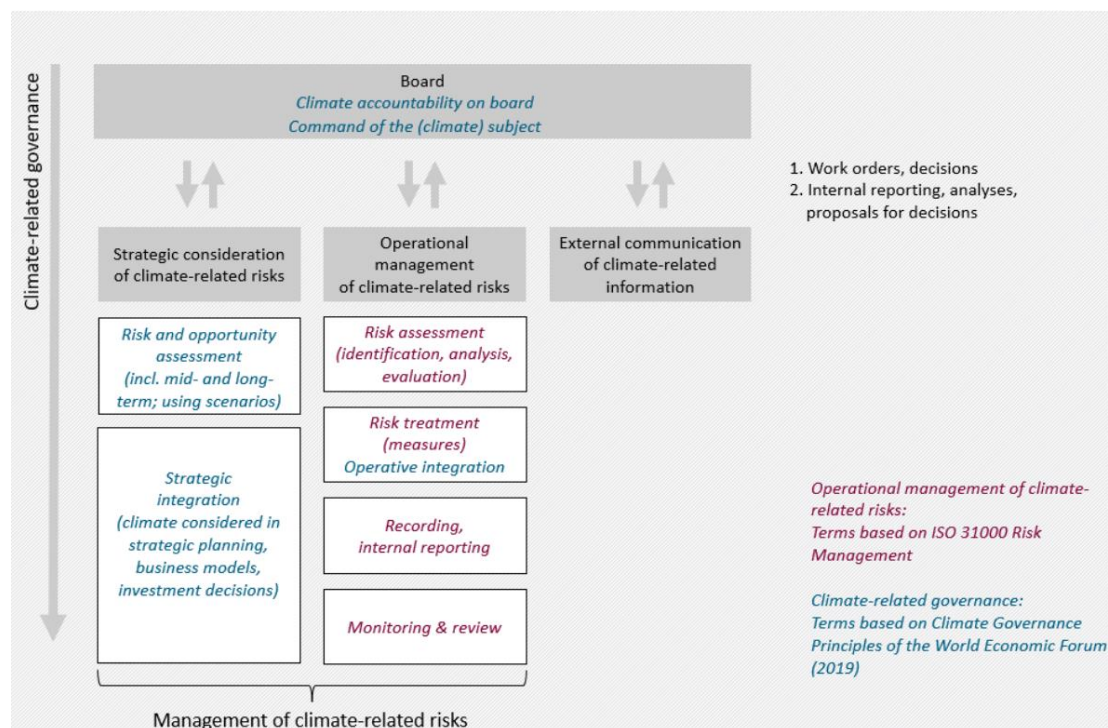
While the awareness on social and environmental issues has been growing within the sector in recent years and was also highlighted by WV Metalle, limited information seems to exist on climate risks and the potential interlinkage with damages through rights violations.

### 2.2.3 Risk management strategies

Within this section, a short overview on climate risk management is provided in order to then look at possibilities and practices of reducing transboundary climate risks and increasing opportunities for the German real economy.

Loew et al. (2021) differentiate companies’ climate-related risk management in a strategic and an operational management, presented in Figure 5. On the strategic side, this covers a

medium- to long-term risk and opportunity assessment and an integration, for example, in investment decisions. On the operational side, risk assessments are rather short-term and the management includes operational measures, reporting and monitoring.



**Figure 5: climate-related risk management (Loew et al. 2021)**

A strategic climate risk management of international trade relations would therefore include an assessment of entire supply chains and potential markets, strategic decisions on investments abroad, international business partners and supply networks. The 2018 version of the ISO 31000 is mentioned by Loew et al. (2021) as a standard for risk management also including a strategic dimension. For climate risks it can be complemented by the ISO 14091:2021, which comprises guidelines on climate vulnerability, impacts and risk assessment. Among the main risk management principles of ISO 31000 are the avoidance, reduction and transfer of risks. While this case study looks at different stakeholders with a general focus on risk reduction, sections 2.3.2 and 2.3.3 pick out risk transfer through insurance schemes.

Information provided by WV Metalle shows that the metal industry's general risk management strategy is given by the very high diversification of its supply chains through a multi-supplier system (Niese and Hackert, 21/04/2021). Various countries and mines are integrated in this system through individual supply companies. Based on daily information on production capacities and prices, German companies can make purchase decisions in a highly flexible manner. Should a major source of supply fail due to a climate-related or other event this system allows to switch to other suppliers without delay. However, this is only the case where market concentration and the dependency on one or a few suppliers is low. Additionally, members of WV Metalle state that they introduced Kanban systems to better manage their supply chains, thereby further reducing potential risks.

In regard to operational climate risk management, reporting is one of the main instruments. Major companies now report on a regular basis according to the TCFD framework and an analysis of the Dax-30 companies by Loew et al. (2021) showed that climate-related risks are considered by all of them. The same analysis demonstrates that transition risks clearly receive the highest attention by all companies – 13 companies who monetarised climate-related risks

in 2019 indicated 36 transition risks with expected losses of EUR 8.9 billion EUR, compared to 16 physical risks estimated at 2.2 billion Euro. While both types of risks, physical and transition, are addressed jointly as climate-related risks in the companies' reports, a clear emphasis on the transition to a carbon neutral economy can be noticed.

Besides the risks described before, the transition of international markets in the context of climate change also provides opportunities for the German industry and private businesses. Wolf et al. (2021) refer to various studies which see a high potential for environmental technologies due to climate mitigation and adaptation requirements, particularly in emerging economies and developing countries. While Germany was one of the three leading countries of the Ecolnnovation Index since 2013, scores for 2019 went down to the 6<sup>th</sup> position (European Commission 2021). Nevertheless, individual indicators of the index show that even though Germany ranks below EU average on enterprises introducing eco-innovations as well as employment in eco-industries, it is the leading EU member state for the export of products from eco-industries. These results imply that Germany's economy is already responding to current global demands. Nevertheless, there seems to be room for incentivising and supporting a larger share of the German real economy, particularly small and medium sized companies.

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## 2.3 Supporting stakeholders

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### 2.3.1 Federal Ministry for Economic Affairs and Energy (BMWi)

With its executive powers the BMWi presents a regulating as well as supporting institution for the German real economy. One of its main goals is "to make the energy transition a driver for modernisation, innovation and digitisation" (BMWi 2021b). Accordingly, climate change is on the Ministry's agenda not only as a requirement to reduce emissions but also as an opportunity, which it supports through information, networks and funding, among other services. When looking at foreign trade the BMWi represents the interests of the German economy through bi- and multilateral cooperation. It also provides services, such as the access to industrial experts in some of the German Chambers of Commerce abroad, who facilitate German companies the access to local markets and networks (BMWi 2021c).

Climate policy at BMWi is covered by two departments, the IVC2 responsible for international climate and environmental policies and the IVC3 coordinating the national climate policy, including climate adaptation. The IVC3 also participates at the inter-ministerial working group on adaptation (IMAA). When it comes to climate risk management in international trade, the department has a more strategic focus, while operational aspects are the responsibility of department V for foreign trade. However, according to Lars Oberg, the Head of IVC3, transboundary climate risks aren't covered by either of the departments yet (Oberg and Leimner 15/06/2021). He explains that the IVC3 currently experiences an urgency in climate mitigation, particularly after the German Federal Constitutional Court ruled in April 2021 that the 2019 climate protection act is partly unconstitutional and requires clearer reduction targets.

Nevertheless, Oberg and Leimner state that their department already planned to develop the subject of climate-related risks and opportunities further, which had to be postponed to 2022. Of major interest in this context seem to be the opportunities for the German economy in exporting green technologies. In regard to climate-related risks and in particular physical risks the department developed the climate check tool "Klimacheck" in 2014, informing and guiding small and medium-sized companies on the management of climate risks (Kind et al. 2014). It is an excel-based tool with an accompanying manual, openly accessible at the BMWi's website, which helps users to identify and rate relevant risks for their company with



recommendations on risk management measures. Figure 6 shows the starting page of Klimacheck, including an overview on the various steps.



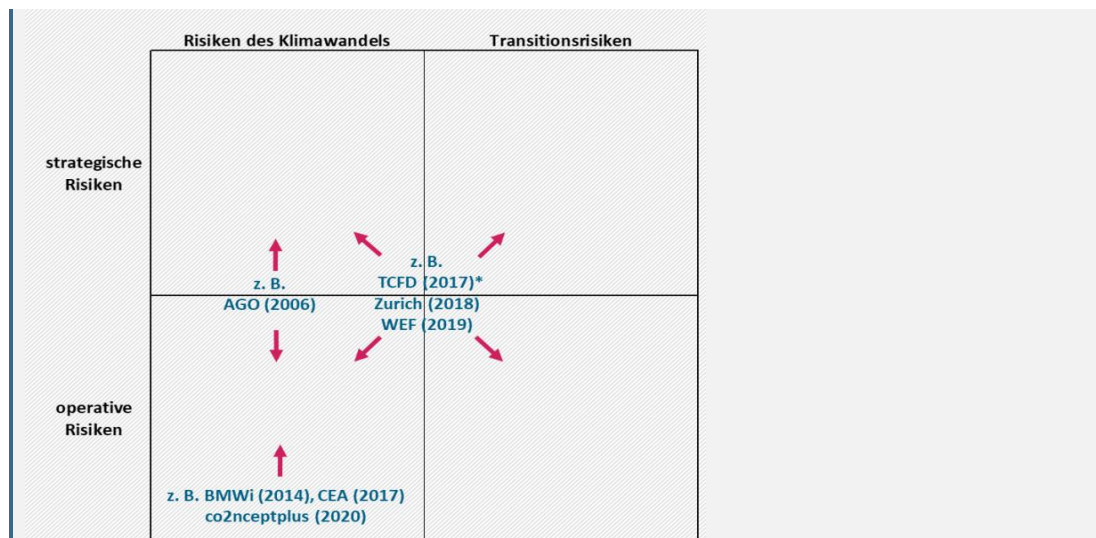
**Figure 6: BMWi climate check tool (BMW 2014)**

The use of this tool by companies so far has been limited and it is currently of little relevance according to Oberg and Leimner. They explain the low demand partly due to a lack of communication and supporting structures, besides considering the tool's contents as outdated by now. Oberg emphasizes the importance to develop the topic of climate-related risks more strategically at his department and would foresee the development or update of such tools as a subsequent step.

### Climate risk support tools

Aside from Klimacheck, other tools and guidelines exist which guide companies in the assessment and management of climate-related risks in their area of business. As reported by Peer Seipold from GERICS (05/08/2021), over 60 similar tools have been developed in Germany, out of which about 30 are currently active.

Loew et al. (2021) provide an overview on the guidelines' focus, as presented in Figure 7, differentiating between physical versus transition risks on the horizontal axis and strategic versus operational risks on the vertical axis.



**Figure 7: Guideline contents for climate risk management (Loew et al. 2021)**

According to this analysis, there are mainly two groups of climate risk management guidelines. One group focusses on the operational dimension of physical climate, mostly by assessing (international) value chains. It has a practice-oriented character, supporting companies in the identification of risks and relevant management measures. The other group has a more holistic view on climate-related risks and also includes the strategic level of a company's risk management. It therefore provides more of a framework for transparent reporting and investment strategies.

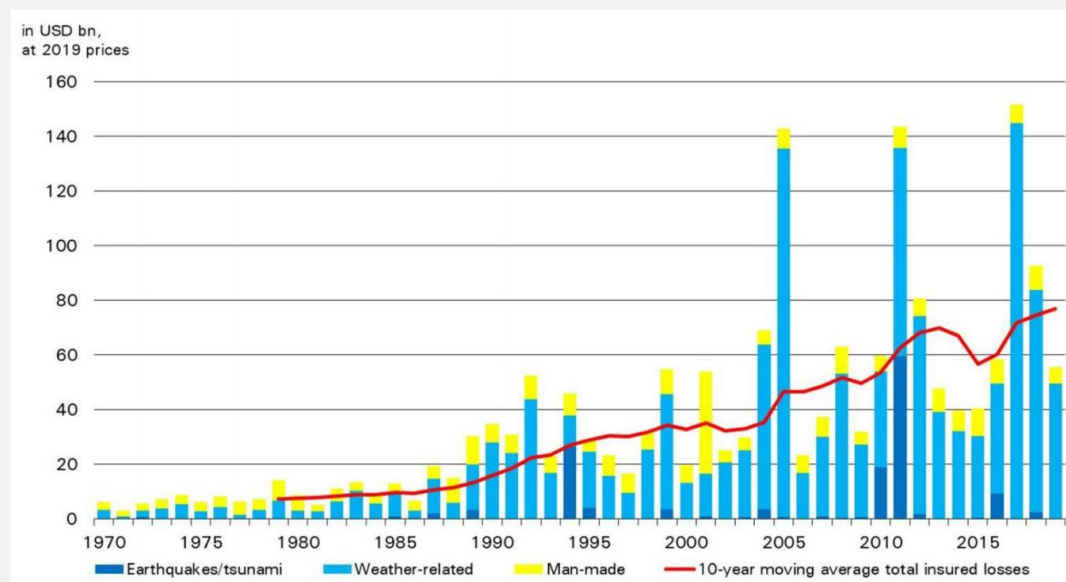
The trend towards a risk focus on climate-related regulatory and market transitions is also reflected in the recommendations for a sustainable finance strategy presented by the Sustainable Finance Committee in March 2021. In its foreword, government representatives including the BMWi state that "[the] central priority is to manage the financial risks of the upcoming transformation while simultaneously taking advantage of the opportunities that arise" (Sustainable Finance Committee to the German federal government 2021: 2). The Committee includes climate risk management in its recommendations on reporting requirements, naming primarily transition and litigation risks, along with physical risks. Reporting requirements refer directly to the TCFD standards, proposing the inclusion of small and medium-sized enterprises in the reform of the Non-Financial Reporting Directive (NFRD). Assuming that these recommendations will be put in practice by the German Federal Government, they would have an influence on the BMWi's strategy and engagement. While transition risks seem to become a priority, reporting requirements would also include physical risks. An increasing demand for risk management support, especially from SMEs, can be expected as a consequence.

### 2.3.2 (Re)insurance companies

The role of insurance and reinsurance companies in managing transboundary climate risks is twofold. On the one side they are affected by the impacts of climate change, covering for damages caused by extreme events as well as other climate-related economic losses. On the other side they provide the investment, underwriting and advisory service for companies to reduce their risks. In this context, Sweeney states that "with global assets under management of more than \$13 trillion, and premiums of \$6.3 trillion, the insurance sector has a substantial and unique role to play" (Sweeney 2020).

### Insurance rates of weather- and climate-related extreme events

Yet, when it comes to climate risks, only a portion of the damages caused by extreme weather- and climate-related events is covered. Figure 8 illustrates that although insurance rates are gradually increasing since the 1980s, they don't fully cover extreme years such as 2011 with the Fukushima tsunami and the floods in Thailand.



**Figure 8: Overview on insured losses, globally (Sweeney 2020)**

In their latest review on the 2020 damages by natural disasters, MunichRe indicates that out of 210 billion USD only 82 billion USD were insured (MunichRe 2021a). While damages of almost 40 billion USD in the USA were covered at large, a major flood in China accounted for damages of 17 billion USD, with only 2% being insured. The figures also show that insurance rates are the lowest in developing and emerging countries.

In contrast, the Thai floods in 2011 are one example of an extreme weather-related event with a global economic impact which had a high insurance coverage. The floods led to a stop of local production and as a consequence to shortages of global supplies, particularly in the IT and automobile industry. Reinsurance companies played a major role in covering for the damages, with claims of 108 billion USD “making it the insurance industry's second-costliest natural disaster year on record” (Neligan 2014, p. 10) at that time.

In regard to physical transboundary climate risks, insurance companies cover various risks along supply chains. Due to the type of risk, climate risks are often insured by reinsurance groups such as MunichRe and SwissRe. One major challenge of climate insurance, according to Rauch (19/04/2021), is that insurance solutions commonly work at an annual basis, not matching with the medium to long term climate risk trends. Still, Rauch claims that the insurance sector nowadays had products available to cover all types of risks along supply chains and that major global companies would make use of them. While principally property losses are insured, he sees a major lack in the coverage of production deficits by the large number of small to medium sized manufacturers with global supply chains. Due to the costs of insurance products, the lack of information in regard to supply chains as well as different risk perceptions of industries and businesses, the demand for climate risk insurance by German companies remains limited (Rauch 19/04/2021).

In the wake of the Covid-19 pandemic, Rauch (19/04/2021) further states that the general awareness of systemic risks and the resilience of markets increased and that this would also

reflect on climate risks. A further driver is the TCFD, as mentioned under section 2.3.1. With a reform of the NFRD, as suggested by the Sustainable Finance Committee, climate risk awareness and action could then also increase among SMEs.

Besides insurance products, reinsurance companies also offer consulting services on climate risk management to their clients. MunichRe mainly consults primary insurers and industries, Rauch highlighting the company's own software solutions for location analytics. This software comprises two modules for assessing locations or entire portfolios, one focussing on future climate change risks based on forecasts, the other on the exposure to natural hazard based on past events (MunichRe 2021b). While this software is looking at physical climate risks, Rauch confirms the before mentioned trend within the financial sector and real economy towards an interest in and management of transition risks. For both, physical and transition risks, Rauch still sees a large need for counselling which isn't covered by the relevant institutions yet. He states that "companies feel left alone" (Rauch 19/04/2021), especially in regard to SMEs who don't have the means to insure all risks in their supply chains.

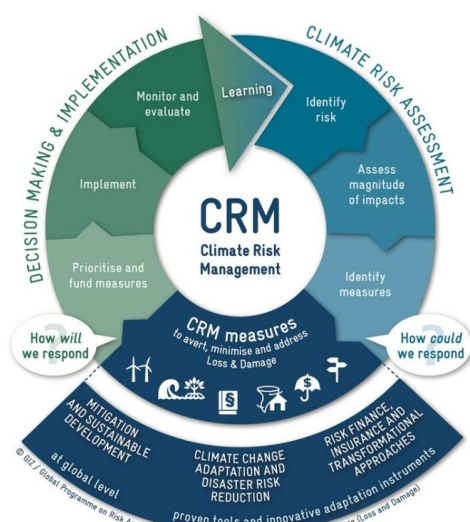
Also, at a global scale, climate risks are only partly covered by major reinsurance groups, mainly for the large industries. Accordingly, national insurance systems in vulnerable countries play a crucial role for a sustainable risk transfer, particularly for local companies as well as individuals (e.g. farmers). However, the availability of and access to insurance against climate risks in vulnerable countries is often limited. Grippa et al. indicate that as a result of increasing loss through natural disasters "insurance is likely to become more expensive or even unavailable in at-risk areas of the world" (Grippa et al. 2019). Initiatives to strengthen national insurance systems exist within the German and international cooperation will be covered under the following section.

### **2.3.3 International (development) cooperation**

The Paris Agreement points out that developing countries face particular challenges in managing the impacts of climate change, by "recognizing the specific needs and special circumstances of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change" and by "[t]aking full account of the specific needs and special situations of the least developed countries with regard to funding and transfer of technology" (Paris Agreement 2015: 1).

The international development cooperation can play a crucial role in strengthening the capacity of governments and institutions, including climate risk management at various levels. It provides access to finance, technical assistance, technologies and infrastructure in support of climate adaptation and disaster risk reduction (DRR). In regard to the subject of transboundary climate risks, this support can be beneficial by contributing to the resilience of export markets.

Looking at the German development cooperation and particularly GIZ, support to vulnerable countries in regard to climate risk management is provided at different levels. GIZ considers three steps of climate risk management, visualised in Figure 9: 1) a policy support level; 2) a methodological risk assessment approach and 3) sector-specific, project-based measures.



**Figure 9: GIZ climate risk management approach (GIZ 2021)**

According to GIZ “[c]omprehensive and effective risk management combines climate adaptation, disaster risk management and social protection methods as well as market-oriented and innovative financial instruments such as risk financing and climate risk insurance” (GIZ 2021). For the purpose of this analysis, the InsuResilience Global Partnership and the Global Initiative on Disaster Risk Management (GIDRM) are highlighted in the following.

### **The international cooperation’s climate risk insurance schemes**

The international cooperation has been investing in climate risk insurances in vulnerable countries for over a decade, targeting governments, businesses, farmers, as well as individual households. The German Government together with the G20+ and V20 established the InsuResilience Global Partnership in 2017, counting over 100 members from governments, civil society, private sector, among others (BMZ 2021). Under this umbrella and financed through KfW Development Bank, it participates in internationally funded climate risk insurance and financing frameworks such as the Caribbean Catastrophe Risk Insurance Facility (CCRIF) since 2007, the Global Index Insurance Facility (GIIF) since 2010 supporting the expansion of index-based agricultural insurance, the Global Risk Financing Facility (GRiF) since 2018, the African Risk Capacity (ARC) and ARC Replica; and the InsuResilience Solutions Fund (ISF) since 2018/19 providing expertise and funding for the development of sustainable climate risk insurance products.

The above mentioned insurance products include direct and indirect insurance types, the first covering losses of individuals and businesses through financial benefits, the latter payouts to governments to enable quick local action. Some of the insurance frameworks emphasize the use of incentives and direct support to their clients to reduce their risks (e.g. through adaptation measures). Another particularity of some climate insurances lies in the disbursement of insurance values in a very short time after the occurrence of an extreme climate event. While the main goal of these insurances is to contribute to poverty reduction under increased climate risks, it also increases the general resilience of communities and local economies in a region.

The recent commitment of the G7 following the Leaders’ Summit in Carbis Bay, Cornwall to protect 500 million poor and vulnerable people against climate shocks by 2025 (ReliefWeb



2021) reinforces the international engagement and further development of climate risk insurances.

The InsuResilience Global Partnership is probably one of the most extensive supporting mechanisms in international development when it comes to climate risk management. It counts 93 members, implementing 218 projects in 101 countries, based on a financial commitment of USD 5 billion. According to Kay Tuschen (03/08/2021) from the InsuResilience Secretariat, the primary target group of InsuResilience are people in vulnerable countries earning less than 15 purchasing power parities (PPP) per USD per day. Nevertheless, he states that insurance schemes and products financed under the partnership also target local economic agents such as SMEs, cooperatives and micro-credit schemes. In addition, GIZ and other partners implement specific climate insurance projects in partner countries such as Peru and Madagascar, focussing primarily on the agricultural sector. In that sense, local economies can benefit from these insurance and financing schemes. Yet, Tuschen comments that the impacts on economies are not measured by InsuResilience, considering that it doesn't present a main objective of the partnership. Furthermore, he argues that the establishment of risk finance and insurance schemes is a lengthy process. In 2020 137 million people have been covered annually by climate and disaster risk finance and insurance solutions, with a target of 500 million until 2025 (InsuResilience 2021).

Although export markets and supply chains are not targeted directly by climate risk insurance and finance schemes such as InsuResilience, they could benefit in the medium to long term. As an example, cocoa farmers affected by El Niño drought events in the West African cocoa belt, as presented by Tirana et al. (2021), face difficulties in accessing finance to implement adaptation measures. An insurance against drought risks, combined with other risk financing instrument, could increase the resilience of cocoa farming and cocoa supply in the region.

The German development cooperation, under GIZ and KfW Development Bank, implements further programmes and projects in partner countries that can have beneficial effects on local economies and international supply chains, comprising climate adaptation and disaster risk reduction, private sector development, agriculture and tourism. In addition, GIZ dispatches so called 'business scouts for development' to chambers of commerce and business associations in Germany and abroad – these experts support German companies in their trade relations and investments abroad with an emphasis on sustainable development.

The GIDRM provides an example of a development program with potential impacts for German supply chains. It started in 2013 working with partner governments from vulnerable piloting countries as well as the private sector. In its first phase GIDRM targeted SMEs in South-East-Asia, among other regions and beneficiaries. The iPrepareBusiness facility was established at the Asian Disaster Preparedness Center (ADPC), as a support unit for SMEs as well as governments to strengthen resilient businesses and investments. The facility also developed training packages for disaster risk management in international supply chains. Trainings were applied for Isuzu Motors Co. (Thailand) Ltd. to capacitate suppliers in Thailand on risk assessment, preparedness and response. Another focus of GIDRM's phase I was the tourism sector, with the 'Hotel Resilient' aiming at an increased resilience of tourism destinations through capacity building and standards for hotels. Furthermore, GIDRM approached German companies and established a business network under participation of the BMWi in order to strengthen awareness on climate risks in supply chains, while also providing the opportunity for companies to receive information on potential markets for relevant technologies. While, according to project coordinator Jaqueline Begerow (06/05/2021), the general interest of German companies was positive and potentials for engagement in disaster risk management activities were communicated, direct initiatives during and following the programme were limited to local and regional stakeholders. She gives the example of the globally well-known German travel company TUI who welcomed the initiative of standards and certification for resilient tourism, at the same time being cautious in providing investment and applying standards due to possible disadvantages on the market. Begerow explains that most

companies in the German business network didn't regard disaster risk reduction as relevant for their business, mentioning the exception of Dräger who recognised the importance for its own procurement processes. In this context she sees a great need to strengthen communication and coordination between the international cooperation and the real economy, e.g. through existing networks and groups such as the inter-ministerial working group for the implementation of the Sendai Framework.

The above gives an insight into some of the German development cooperation's activities on climate risk reduction in vulnerable countries. While the resilience of German supply chains and international trade isn't a main goal of such projects and programs, co-benefits can be achieved through the strengthening of governments and local economic agents in disaster risk management, together with climate resilient investments. Furthermore, the development cooperation agencies offer a comprehensive knowledge pool in various sectors and countries. This expertise is so far used by the German real economy through the 'business scouts' mentioned above.

A wider approach to inform and capacitate the German real economy on transboundary climate risk management could further integrate the development cooperation's expertise, tools and experience in a more strategic way. Valuable methods and tools concerning disaster risk reduction and climate adaptation can be of use for government and economic agents. To highlight only one, the GIZ's Climate Expert tool mainly targets SMEs and industrial zones in developing and emerging countries to assess their physical climate risks and develop adaptation strategies. Companies in Germany and in vulnerable locations of supply could receive training and use the tool to reduce their own climate risks, with positive effects on the resilience of entire supply chains.

### 2.3.4 Chambers of commerce

The German real economy comprises a variety of associations and organisations, functioning as representatives, networking agents and service providers. The WV Metalle was mentioned before as one of these agents, representing the non-ferrous metal industry. In the following, chambers of commerce are highlighted, due to their leading role as representatives of German companies as well as their services, providing business support to member companies in Germany and abroad.

The German chamber of commerce functions at a regional level through 79 IHKs (chambers of industry and commerce) in Germany and 140 AHKs (foreign chambers of commerce) in 94 countries (DIHK 2021). In total, the IHKs count over 3 million member companies from small businesses to large industries. On the one side, the IHKs inform the policy level and provide lobbying for their members. On the other side, they serve as networking agents and provide up-to date information as well as capacity building to their members. The AHKs are the direct contact for German companies abroad, offering support regarding country-specific information, contacts and assistance in entering local markets. Accordingly, both the IHKs and AHKs present potential stakeholders who could play a role in informing and capacitating their members in regard to climate risk management in Germany and abroad.

An internet research showed that the IHKs hardly address climate-related risks on their websites, yet some provide information under the topics of sustainable supply chains and climate mitigation.<sup>3</sup> This includes links to the BMWi Klimacheck tool, as well as other manuals and funding schemes for climate risk management and adaptation. Individual IHKs offer support, such as the IHK Dortmund; others already offer trainings on climate risks at a local and regional level, including the IHK Siegen and IHK Bremen. The latter conducted a specific series of seminars called "KLIMARISIKEN BINNEN" which also included physical risks in

<sup>3</sup> In the aftermath of the flood events in Germany in July 2021, specific information on flood risk management as well as support options for affected companies were communicated by the DIHK and individual IHKs on their websites.

supply chains. It was organised with the business development scout Talis Zvidrins, who states that the topic of transboundary climate risks is not very common amongst the IHKs due to the low demand from members (Talis Zvidrins 04/08/2021). He reports that the interest in the seminar was relatively low compared to topics of sustainability, where the pressure on companies is much higher due to the new legislation. In his experience, climate risks in supply chains are perceived as indirect by companies. They may observe, for example, rising prices after an extreme event, but don't see their business affected. Furthermore, Zvidrins explains that while individuals at the IHKs may be aware and informed about climate risks, member companies and particularly SMEs often lack the capacities to further engage in this area. He therefore suggests a low-threshold support and tools together with further awareness raising. At the same time, he expects the finance sector to be more of a driving force in the future, increasing the pressure on companies in order to secure returns on investments.

When it comes to the general support and information for German companies abroad, the AHKs play an important role. Companies that hold or want to establish trade relations abroad are likely to connect with the AHKs in the relevant country, requesting information on market conditions and risks for their business. Accordingly, they could also be a relevant source of information on climate risks. Nevertheless, when asked about current demands for climate-related information, the Director of the German-Thai Chamber of Commerce explains that in the past years flood or other climate-related risks have not been of any relevance in communications with German companies (Roland Wein 18/05/2021). Accordingly, this topic is currently not on the agenda of his office. Considering the large impact of the 2011 flood events in Bangkok on international supply chains, it is surprising that companies are not approaching the AHK in this regard. In Thailand, Wein comments, local environmental problems play a more important role for the chamber and its members. Wein points out the chamber's GTCC Clean Air Initiative, which promotes clean and more sustainable Thai industries through lobbying at the political level. He explains that air pollution is a health hazard in Bangkok and other regions, impacting the quality of life and attractiveness of the location for German companies to invest as well as for their international employees. At the same time, the chamber sees a potential for German environmental technologies, should national policies increasingly regulate air pollution. When questioned about who German companies should contact for information in regard to climate risks in Thailand, Wein still considers the AHK as relevant for the provision of general local information. He further adds that in the case of an extreme event in Thailand, the AHK would also be a contact point for member companies to receive information and support.

In sum, the services provided by the IHKs and AHKs directly reflect the demand of the German real economy, which is very limited in regard to physical climate risk management in international trade. On the contrary, current activities demonstrate a high interest of member companies in receiving support for climate mitigation and sustainable supply chains, as well as opportunities to enter new markets for green technologies.

### 2.3.5 Climate service providers

Climate data is provided by a number of institutes in Germany, including the Potsdam Institute for Climate Impact Research (PIK) and the German Aerospace Center (DLR), amongst others. Yet, data and publications are often aiming at users from science as well as the public sector and the interpretation by companies for their own climate risk management can be difficult. Specific climate services for the private business sector are marginal, as already pointed out by Rauch (19/04/2021). MunichRe targets only clients with their in-house software and is therefore not relevant for most of the SMEs in Germany.

In this context, the GERICS is one of the few facilities also targeting companies with their products. It was founded in 2009, since March 2021 being an institute of the Helmholtz-Zentrum Hereon. GERICS developed a climate service prototype named



“Unternehmensbaukasten” (entrepreneurial kit) to support the adaptation of companies to the impacts of climate change, combining scientific data with practice (Groth and Seipold 2017).

**The “Unternehmensbaukasten”** (entrepreneurial kit) is a custom-made product, based on a series of interviews with companies and was developed as a prototype. For its assessment framework, the service uses value chains and value levers, identifying the companies’ activities with potential climate risks as well as production factors and stakeholders with an influence on turnover and profit. The economic model of value drivers is then used to identify the potential influence of climate change on the companies’ financial results and activities. The assessment framework comprises 55 questions, concentrating on the areas of i) management and leadership, ii) market, iii) finance, iv) infrastructure, v) production and logistics as well as vi) human resources.

In the application process, Groth and Seipold identified a specific demand in estimating financial impacts of climate change on property, assets and amortisation (Groth and Seipold 2017). They also refer to the clients’ positive feedback in regard to the individual assessment and recommendations provided by the service. Furthermore, positive effects are seen in an increased awareness and establishment of the topic adaptation within the companies, as they involved strategic functions rather than environmental departments in the assessment process. The main challenge Groth and Seipold found during the application of the *Unternehmensbaukasten* relates to the expectations of entrepreneurs regarding concrete monetary risk calculations. Their experience correlates with the observations by Rauch (19/04/2021) that the scientific evidence on climate change is based on scenarios of 30 years and more, while strategic planning horizons of companies are 3 to 5 years.

In comparison to other climate check tools for companies, the GERICS *Unternehmensbaukasten* is more complex, providing individual information and involving key staff of companies. While this approach seems to be closer to the companies’ needs, it also requires specific expertise to be implemented.

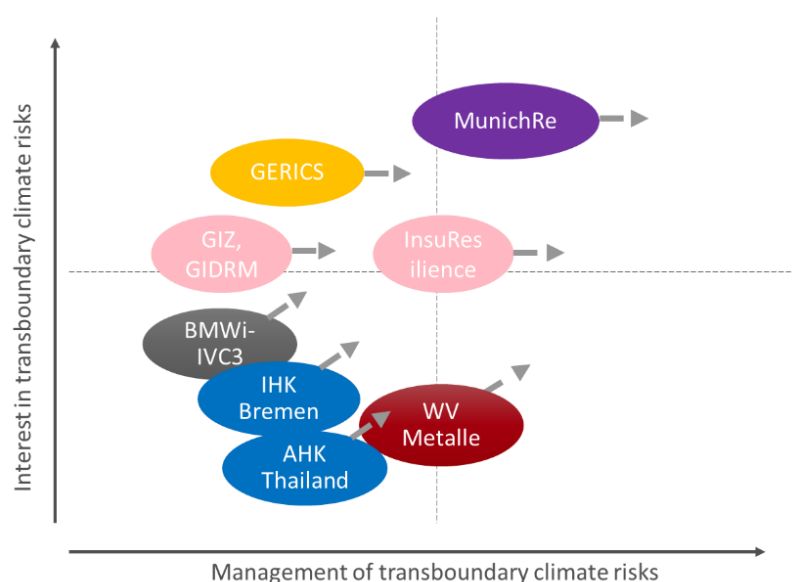
GERICS developed the *Unternehmensbaukasten* as a prototype and is not directly providing the application of its modules as a service for companies, according to Seipold (05/08/2021). Consequently, the implementation would need to be done by experienced consulting companies or institutes, which is not clear at the moment as GERICS still continues to further develop single modules and tools of this product. When considering the otherwise low demand by the German real economy, the question arises on how to promote this product (or individual tools within it) in the future. Seipold recognizes the currently low awareness, especially amongst SMEs due to their limited capacities. His experience shows that even larger companies find it difficult to differentiate between climate mitigation and adaptation or risk reduction in the consultation process. As a result, the topic is often addressed by staff in charge for corporate social responsibility instead of those responsible for the company’s risk management. He also comments that about 30 different active tools exist for climate adaptation or risk assessments, which however are not being used. As reasons, Seipold argues that climate adaptation in contrast to mitigation has to do with internal processes of a company and is often much more abstract, while also being unsuitable for public communication. GERICS so far was approached more by associations, foundations and consulting companies who were interested in the application of the tool. Individual companies only contacted them for location-specific information in Germany and Seipold explains that in

the process of consultation, the relevance of climate risks in supply chains then also became evident.

As a result of the July 2021 flood events in Germany, requests with a local interest in climate risk management could further increase. Still, Seipold sees a general need for regulatory instruments such as the EU Taxonomy Regulation in order to raise the relevance of the topic for German companies. Furthermore, he makes a point that it needs ‘carers’, meaning experienced individuals who are trusted by companies, in order to work on this sometimes sensitive issue touching various areas of a company’s management and operation. These individuals could come from relevant institutions or consultancies. They could also be experts from single IHKs, while Seipold doesn’t expect the IHKs in general to have or develop this specific expertise and to play a leading role in advising member companies on transboundary climate risk management.

### 3 Conclusions

The case study presented eight individual stakeholders who already or potentially play a role in managing climate-related risks and opportunities in the context of German international trade. Based on a stakeholder analysis, the case study introduced each of the stakeholders and looked at their perceptions on transboundary risks in their field of work, existing action in risk management as well as opportunities and barriers for their engagement in the future. The findings are visualised as a stakeholder map in Figure 10. It can be understood as a generalised picture of where the stakeholders seem to find themselves momentarily in addressing and managing transboundary climate risks. The stakeholder map further indicates potentials for future engagement (grey arrows). These findings are partly based on the interviews conducted, partly on observations and conclusions from the analysis of each stakeholder. A short interpretation of the stakeholder map is given below.



**Figure 10: Stakeholder mapping on transboundary risk management (own illustration/adelphi?)**

**WV Metalle** finds itself with a relatively low interest concerning transboundary climate risks. The interviewees understand disruptions of metal ore production due to weather extremes as “daily business” (Niese and Hackert 21/04/2021) and have so far not experienced negative trends they would relate to climate change. At the same time, members of WV Metalle reduce risks in their supply chains through diversification and supply chain management. Even with a predicted regional increase in climate-related risks, overall German metal (ore) supplies may therefore not be impacted as much. Nevertheless, for metal ores originating from very few vulnerable countries or one region, climate-related risks could affect the German metal industry progressively. In this regard, the issue of transboundary climate risks should be given more attention. The WV Metalle could play a role to advance this discussion and to establish contacts with other stakeholders for information and support.

**The BMWi’s department IVC3** focusses fully on climate mitigation at the moment. Yet, it plans to put climate adaptation including transboundary climate risks on its agenda for 2022. Having developed the “Klimacheck” tool for companies in 2014, the department observed a lacking demand by German companies for the use of such tools. Recognising the climate-related risks and opportunities in international trade, the department sees the necessity to engage more

strategically in this subject. It is therefore expected to increase its interest and action in the future with a potential to influence and support the German real economy's transboundary climate risk management.

**MunichRe** offers its clients a diverse range of insurance products and advisory services on climate-related risks. Companies could insure against most of the physical climate risks in their supply chains and major global companies already do so. Yet, this is not the case for most of the German companies, which may lack the information and capital to take out such an insurance. In general, the interviewee reported that support for German SMEs was missing, also in regard to transition risks and opportunities (Rauch, 19/04/2021). Accordingly, there is a large potential to increase the coverage of insurance products in Germany in addition to other risk reduction measures. On the other side, insurance schemes in vulnerable countries also play a role in establishing climate resilient export markets.

**The InsuResilience Secretariat** is managed by GIZ and coordinates the various funds under the InsuResilience Partnership that finance and support climate risk insurance in vulnerable countries. Although these insurance schemes do not target international trade, they have an influence on the resilience of local economies. With its steady increase of beneficiaries, this could also have a positive effect on transboundary climate risks in the future.

**The GIZ Global Initiative on Disaster Risk Management (GIDRM)** is one example of a GIZ programme supporting disaster risk reduction in vulnerable countries. The GIDRM, in its first phase, partly looked at transboundary climate risks and opportunities with an involvement of German companies. There still is a high interest and know-how for further engagement, although funding for the recent phases had a different focus.

**The IHK Bremen** is one of the few German IHKs that is currently offering information in regard to transboundary climate risks. The topic was introduced by a development business scout, who states that the chambers generally face a low demand (Talis Zvidrins 04/08/2021). Considering the role of the IHKs, there is nevertheless a potential for them to promote climate risk management in general and engage in raising awareness, informing and supporting their members.

**The German-Thai Chamber of Commerce** has not been approached on the topic of climate-related risks in the past years by companies, even though the 2011 floods in Bangkok affected companies and their supply chains globally. At the same time, the chamber is active in lobbying for clean air in Thailand and in promoting German technologies (Roland Wein 18/05/2021). This already shows its high potential in supporting the export of carbon-friendly technologies. At the same time, it could become more active in raising awareness and providing information on local climate-related risks.

**GERICS** provides expertise and tools for climate adaptation, also targeting German companies. With the climate service "Unternehmensbaukasten" they developed a prototype for companies to assess the climate-related risks of their business. GERICS is not responsible for a direct consultation of companies, but they are a relevant stakeholder for informing and capacitating representatives of the real economy on climate risk management.

The results from the stakeholder mapping already present possible links between each of the stakeholders and their overall potential to engage further in the management of transboundary climate risks. The mapping however is not exhaustive, as it only looks at those stakeholders identified within the boundaries of this case study. Should one of the stakeholders above or another actor decide to increase their own engagement, it is recommended to develop an own stakeholder analysis.

Further research could also look at regulating stakeholders and/ or frameworks and their influence on reducing or increasing climate-related risks and opportunities. This may include national policies, strategies and measures of climate risk management in Germany and abroad, considering their impact on international trade. As an example, climate-resilient

standards in construction could result in a demand for technologies and create a market for specialised German companies. Along with regulations, funding is also a key driver for investments in and the development of green technology markets. Wolf et al. (2021) point out the export initiative for green technologies by BMU together with support through EU frameworks for innovative green technologies.

Overall, most stakeholders identified the international financial market as the strongest influence when it comes to positioning climate-related risks within Germany's real economy. For the major DAX companies, the TCFD framework is already a standard. Furthermore, international politics play a decisive role in setting the agenda of the financial sector and economy. In June 2021 the G7 agreed on a mandatory corporate climate reporting based on the TCFD standard. For the sum of the German companies, the subject will already be of higher relevance once they are required to report on climate risks, among other criteria, as part of the new Corporate Sustainability Reporting Directive (CSRD) by the EU. It is likely that the interest in and action on transboundary climate risk management will then also increase for stakeholders such as WV Metalle and the chambers of commerce.

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## 5 Annex I: Interviews

NAME	INSTITUTION AND POSITION	DATE
<b>Rauch, Ernst</b>	MunichRe, Global Head Climate & Public Sector Business Development	19/04/2021
<b>Niese, Michael and Hackert, Pia</b>	WV Metalle, CEO and Manager/ Division of sustainable supply chains and trade relations	21/04/2021
<b>Begerow, Jaqueline and Bentfeld, Mareike</b>	GIZ, Head of Programme/ Manager, Global Initiative on Disaster Risk Management (GIDRM)	06/05/2021
<b>Wein, Roland</b>	German-Thai Chamber of Commerce (Head Office), Executive Director	18/05/2021
<b>Oberg, Lars and Leimner, Daniel</b>	BMWi (Federal Ministry for Economic Affairs and Energy), Head of Department/ Manager, Department IVC3 – Coordination of the national climate policy	15/06/2021
<b>Tuschen, Kay</b>	GIZ, Junior Advisor, InsuResilience Secretariat	03/08/2021
<b>Zvidrins, Talis</b>	GIZ, Business Development Scout for the IHK Bremen	04/08/2021
<b>Seipold, Peer</b>	Climate Service Center Germany (GERICS), Helmholtz-Zentrum hereon GmbH, Head of Department Networking & Marketing	05/08/2021