The GERICS Process Model Approach to Integrate Future Climate Change Information into Adaptation Strategies

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1 ABSTRACT

Effective preparation for climate change impacts necessitates the proactive integration of scientifically robust climate information into decision-making processes across both the private and public sector. Companies are increasingly confronted with regulatory requirements for non-financial reporting, including scenario-based risk assessments aligned with the EU Taxonomy Regulation. Simultaneously, public institutions – such as counties and municipalities in Germany – are mandated to develop climate adaptation strategies under the Federal Climate Adaptation Act (KAnG), which must be based on the results of climate projections for the near and far future. In response to these evolving demands, the Climate Service Center Germany (GERICS) has developed the GERICS Process Model for Companies, a prototypical climate service product designed to enable decision makers to embed projected future climate conditions into adaptation management. This prototypical model was co-developed through an inter- and transdisciplinary process, emphasizing practical applicability and stakeholder engagement via structured interviews and participatory workshops. The model consists of eight interconnected phases: i. stocktaking, ii. classification, iii. identification, iv. supplying information, v. capability, vi. derivation and implementation of measures, vii. evaluation, and viii. process solidification. It serves as a bridge between scientific climate data and operational decision-making, promoting cross-organizational thinking and supporting both mitigation and adaptation strategies. Based upon successful collaborations with private sector actors, the next step of the prototypical development involves adapting and scaling the model for application within public sector organizations at the municipal and county level. This expansion aims to align with the requirements of the KAnG and to support the development of robust, evidence-based climate adaptation strategies for communities as well as companies connected to these areas.

Keywords: climate change adaptation, climate change information , climate services, co-creation , transdisciplinarity

2 INTRODUCTION

Preparing for extreme weather events and other climate change impacts requires the forward-looking integration of scientifically robust climate information into strategic decision-making processes across both the private and public sector. Companies are increasingly subject to regulatory demands for non-financial reporting, risk assessments and the demonstration of substantial contributions to environmental objectives in accordance with the EU Taxonomy Regulation (European Commission, 2021; Technical Expert Group on Sustainable Finance (TEG), 2020a; TEG, 2020b). One key component is the use of climate change scenarios to consider plausible future climate conditions, which include a range of possible outcomes based on different human activities, particularly greenhouse gas emissions.

Public sector organizations are likewise facing new regulatory frameworks. In Germany, for example, the Federal Climate Adaptation Act (Bundes-Klimaanpassungsgesetz, KAnG) mandates federal, state, and local authorities – including municipalities and counties – to develop and present precautionary climate adaptation strategies. These strategies must be based on state-of-the-art scientific climate risk analyses and incorporate medium- and long-term climate information (BMUV, 2023).

In response to these evolving requirements, the Climate Service Center Germany (GERICS), in collaboration with various companies, developed and tested a prototypical climate service product – the GERICS Process Model for Companies (Gehrke et al., 2025; Gehrke et al., 2024). Its primary objective is to create a practical and user-oriented framework to enable decision makers to systematically integrate future climate information into adaptation management processes. The development process was guided by the principles of transdisciplinarity and co-creation, which serve as fundamental concepts for integrative research (Schuck-Zöller et al., 2024). One goal of this approach was to ensure that scientific insights were translated into

actionable knowledge in a comprehensible and accessible manner. To this end, interviews and workshops were used as effective formats for stakeholder engagement, particularly for participants without a scientific background.

Based upon this, the GERICS Process Model aims to enable decision-makers to assess and evaluate climate-related direct and indirect impacts of climate change for their own strategic planning processes. This should be achieved by using future-oriented climate data in conjunction with company-specific and local information, combined with a holistic view of the respective system in which the company is embedded.

Building on positive feedback and good experiences gained from the collaboration with companies, further prototypical product development will now be continued for public sector stakeholders at the municipal and county level. The goal is to develop a GERICS Process Model for counties and municipalities.

Against this background, this paper briefly introduces the current prototypical product status of the GERICS Process Model and reflects on its practical application, incorporating specific feedback on individual phases as well as questions and challenges raised from corporate decision-makers (chapter 3). Furthermore, it outlines the key requirements of the German Federal Climate Adaptation Act (KAnG) for municipalities and counties to be taken into account to meet the needs of public sector actors (chapter 4). The final chapter presents a brief conclusion and outlook (chapter 5).

3 THE GERICS PROCESS MODEL AND FIRST LESSONS LEARNED FROM THE PRACTICAL USE BY COMPANIES

3.1 The model phases

This chapter briefly introduces the eight-phases of the GERICS Process Model for companies, developed to provide a structured procedure for assessing climate vulnerabilities and identifying the most relevant direct and indirect impacts of climate change – mainly based on promoting transdisciplinary collaboration between internal and external stakeholders.

The eight phases of the GERICS Process Model are as follows (Gehrke et al., 2025; Gehrke et al., 2024):

(1) Stocktaking: Companies start by identifying climate-related events and their potential impacts across operational sites, supply chains, and markets. This includes for example both direct and indirect effects, informed by historical data, stakeholder input, and external sources such as hazard maps and urban climate analyses.

(2) Classification: Identified past, current and plausible future impacts are evaluated by experts in the company in terms of relevance and severity using weighted decision matrices. This prioritization process aligns with strategic objectives and regulatory requirements, particularly those outlined in the EU Taxonomy.

(3) Identification: Key climate variables – such as the number of heat days, drought periods, or heavy rainfall events – are selected based on regional climate projections. The selection of these parameters is tailored to the company's specific context and aligned with regulatory guidelines.

(4) Supplying information: Climate information about relevant climate variables is compiled and adjusted to meet company-specific needs. Products such as the GERICS Climate Outlooks (Pfeifer et al., 2021) provide results of regionalized climate projections that support long-term planning and decision-making.

(5) Capability: Companies are enabled to interpret and apply climate information effectively through targeted training and customized formats. Best practices and case studies facilitate the translation of data into strategic actions.

(6) Derivation and implementation of measures: Suitable adaptation measures are developed and prioritized to enhance organizational resilience. These measures span short-, medium-, and long-term horizons and include "no-regret" options that align with EU Taxonomy criteria.

(7) Evaluation: The success of implemented adaptation measures is assessed through iterative monitoring and evaluation. Key challenges include the attribution of outcomes and the definition of meaningful indicators. The evaluation process also considers stakeholder engagement and the integration of updated climate data.

(8) Process solidification: The aproach is embedded into organizational structures to ensure continuous learning and adaptive capacity building. Resilience is conceptualized as an ongoing process, enabling companies to respond flexibly to evolving climate risks.

In general, the process model is designed to remain adaptable to practical applications by different user groups in different sectors. As a framework it accommodates varying levels of data availability and observational evidence and incorporates feedback loops between phases to support continuous improvement.

3.2 Lessons learned from the current practical use

The prototypical application of the GERICS Process Model for the use by companies has demonstrated that the first four phases – focusing on stocktaking, classification, identification and supplying information – have been the most actively used. In contrast, the transition toward internal integration, facilitation, and evaluation of climate risk management, beginning with phase 5, has only recently been carried out or remains in the planning stages.

In its current form, the approach complies with emerging climate-related regulations and fosters innovation through a structured and systemic framework as well as forward-looking planning. For decision-makers within companies, the phases of the model have proven particularly valuable in organizing internal processes. Moreover, the model offers an easily understandable starting point for engaging with detailed climate change information and anticipated impacts, facilitating internal dialogue and strategic planning.

However, additional explanatory support has been necessary in several areas. For instance, the detailed steps and their sequence within the process require further clarification for decisionmakers. Terminology such as "system elements" or the various climate parameters and their relevance to specific climate hazards were not immediately understood by company representatives confronted with it for the first time, so that the integration of specific external guidance is key at this point. The most substantial feedback and needs for support were related to the understanding and proper use of the climate parameters provided.

A scientific sound basis for these parameters are the GERICS Climate Outlooks (Pfeifer et al., 2021), which offer insights into possible future climatic changes at regional scales. These outlooks summarize common key climate indicators – such as temperature, number of heat days, dry days, wind speed, and heavy rainfall days – in a concise format. The projections illustrate trends of these parameters throughout the 21st century, providing valuable information on how climate conditions may evolve in specific regions of Germany. It is essential to consider both current and projected developments in climate parameters and align them with the specific requirements of each company.

At this stage of the process, companies often identified significant challenges in integrating the climate information into their risk management frameworks. A key issue was how to handle the wide range of potential future climate developments. Risk management practices typically require a focus on one or two scenarios – such as RCP 2.6, 4.5, or 8.5 – and within those, on specific statistical values like the median or a particular percentile. Furthermore, the bandwidth or results within each scenario makes the available information often challenging to be used in practise. Additionally, for certain business-specific questions, the required climate change information is not yet available. This includes data on specific definitions of extreme rainfall events, temperature thresholds, and maximum expected values for temperature or precipitation. Where feasible, these support needs are addressed through the ongoing development of the GERICS Climate Outlooks as well as other climate services. However, some requirements – such as the provision of maximum expected temperature or precipitation values and the combination of two specific indicators of particular interest to a company for new insights – necessitate fundamentally new research efforts. Furthermore, it has to be taken into account, that the climate projections only consider 30-year averages, which makes it difficult to determine robust value intervals for shorter periods.

Moreover, practical experiences show that decision-makers frequently are challenged in delineating their system boundaries and levels of influence relevant to their organization or business model. This difficulty arises partly because the system under consideration – focused on adaptation to climate change impacts – differs often substantially from meanwhile well-established approaches to climate mitigation or other relevant reporting requirements. Consequently, prior experience and knowledge in this domain are typically lacking. Decision-makers also often struggle to establish a causal link between an observed or anticipated vulnerability and the underlying climate-related driver, as illustrated by a tree falling onto a railway track,

which may result from various causes – such as uprooting due to storm or the lowered stability of the soil after a heavy rainfall event. Without a precise identification of this cause, however, it is not possible to determine the appropriate and relevant climate parameter(s).

In summary, several key success factors for the use of the GERICS Process Model have already been identified in collaboration with companies. A basic requirement of this specific approach depends on close, trust-based cooperation between internal and external stakeholders from the outset. Its effectiveness also relies on one or more facilitator(s) in the company who has the resources, position, mandate and capabilities to internally engage all other relevant experts within the company, leverage their expertise and imply knowledge to evaluate and prioritize areas for action as well as to develop appropriate adaptation measures.

The use of the process model also provides significant added value by fostering transformative adaptation solutions to address climate change impacts. This includes promoting new forms of collaboration, encouraging cross-organizational thinking and action, reimagining adaptation needs from a systemic perspective, and involving other relevant stakeholders in addressing climate risks. These efforts can be embedded within a framework of transdisciplinary co-production, ensuring that the resulting solutions are comprehensive, inclusive, and innovative.

Following this retrospective perspective on the experiences of using the GERICS Process Model with companies, the next chapter will take the above findings into account and furthermore focus on the level of counties and cities. The necessity for this is explained below.

4 KEY REQUIREMENTS OF THE GERMAN FEDERAL CLIMATE ADAPTATION ACT (KANG) FOR CITIES AND COUNTIES

To ensure that the current regulatory framework conditions and requirements are taken into account in the further development of the existing GERICS Process Model for use by counties and municipalities, key requirements of the Federal Climate Adaptation Act (KAnG) will additionally be introduced.

With this new federal adaptation act, entered into force in July 2024, counties and municipalities in Germany are now subject to new legal obligations (Schink, 2024; BMUV, 2023). For the first time, this legislation establishes a legal framework for climate change adaptation in Germany, representing a governance-based approach to precautionary climate policy. According to §1, the act aims to prevent or – where prevention is not possible – minimize the negative impacts of climate change. It seeks to enhance the resilience of ecological systems and society to future climate impacts, maintain equitable living conditions, and prevent climate-induced increases in social inequality.

Regarding key conceptual foundations, the following three definitions from §2 are particularly noteworthy:

- Climate adaptation: The alignment with current or anticipated impacts of climate change.
- Climate risk analysis: The identification and assessment of present and future risks associated with the impacts of climate change, whereby the necessary scope and level of detail of the analysis shall be appropriately determined by the legal entity responsible for its preparation, based on its situation and needs.
- Public task carriers: All entities performing public tasks, regardless of whether they are organized under public or private law.

A key legal provision is the requirement that public task carriers give due consideration in their planning and decision-making on a cross-disciplinary and integrated basis to the objective of climate adaptation (§8). This includes both current and anticipated future climate impacts.

Specific obligations for counties and municipalities are outlined in two paragraphes. According to §11, the federal ministry responsible for climate adaptation must receive biennial reports from the federal states detailing which municipalities and counties currently already have climate adaptation concepts developed and which do not. These reports must also specify the regional and local climate data used for adaptation planning. §12 further addresses counties and municipalities indirectly via the federal states. The states are responsible for designating public entities to develop climate adaptation concepts for municipalities and counties where such plans do not yet exist. The catalog of measures should include preventive measures for extreme heat, drought, and heavy rainfall, as well as actions that promote individual preparedness among citizens. Moreover, §12 stipulates that climate risk analyses for municipalities and counties should be based

on vulnerability assessments or comparable decision-making tools providing "hotspot-analysis" that identify priority risks and urgent needs for action. Thus, municipalities may draw on additional sources of information, like adaptation-related representations and determinations within land-use planning, flood protection strategies and heavy rainfall maps. Moreover, adaptation planning by other territorial authorities must be considered – both vertically (e.g., municipal associations) and horizontally (e.g., adaptation strategies of neighboring municipalities). The climate adaptation concept is intended to serve as a sort of catalog of measures tailored to local conditions. It is also acceptable for adaptation concepts to rely on comparable planning foundations, provided that relevant plans and concepts from neighboring municipalities are explicitly considered.

In summary, the KAnG addresses an existing gap by requiring all administrative levels within the federal territory to develop plans and concepts for climate adaptation. This ensures a systematic approach to climate impact issues, albeit in the form of a framework law. However, it must also be noted that the KAnG confronts all administrative levels with complex planning decisions. For counties it imposes several core requirements, particularly due to their role as supra-local administrative bodies and associations of municipalities (Völker et al., 2024). These include, depending on state-level regulations: i) developing climate adaptation concepts, ii) conducting climate risk analyses, iii) coordinating and supporting inter-municipal efforts, iv) documenting and tracking progress in adaptation activities, and v) contributing to the federal states' reporting obligations. The city level may also face significant challenges in developing climate adaptation strategies. Yet, this is precisely where adaptation measures are most critical, as cities are responsible for land-use planning and thus for regulating land utilization, performing public health protection tasks, and, ultimately, planning, implementing and maintaining key critical infrastructure.

Hence another, appropriately adapted GERICS Process Model will go beyond support to address new regulatory requirements and the integration of climate information into strategic planning processes. It also will take into account that adaptation of urban areas and their surroundings is more than creating hot spot maps or developing adaptation strategies. It requires the consideration of many more factors and drivers, including their interactions as well as many interests from key players such as administration (from local to regional), politics, and companies, which makes comunication key for successful adaptation.

5 CONCLUSION AND OUTLOOK

The practical application of the GERICS Process Model approach shows that it sucessfully supports regulatory compliance and structured internal processes for companies, offering a clear entry point for climate-related dialogue and planning. As a framework it also fosters systemic and innovative adaptation strategies through transdisciplinary co-production, promoting cross-organizational thinking and transformative solutions, whereby effective implementation depends on close collaboration with external experts and internal engagement across different departments. However, it was shown, that most companies still require additional guidance on process steps, terminology, and the use of climate parameters. Challenges include integrating localized climate data, managing scenario uncertainty, and addressing gaps in extreme event definitions.

Based on the current experiences, the GERICS Process Model will now be transferred and further developed not only as a methodological guideline but also as a strategic framework to meet the needs of cities and counties. It aims to support the systematic embedding of climate adaptation within administrative structures, budgetary frameworks, and political decision-making procedures. Thereby a close connection and communication with the company perspective in the region will be established to support an integrated approach, bringing together municipalities, counties and companies. The overarching goal is to support and enable decision-makers to systematically identify and assess climate risks and to derive appropriate adaptation measures – with particular emphasis on the implementation of climate risk analyses.

The further development of the GERICS Process Model for municipalities and counties offers great potential for implementing the requirements of the German Federal Climate Adaptation Act (KAnG). It is now planned to identify pilot municipalities and counties to co-develop and test the model exemplary. As part of this transdisciplinary work, especially a close collaboration between science and practice on equal footing in the context of prototypical product development, remains a key success factor for engaging with representatives from counties and municipalities.

Beyond damage prevention and adaptation, this approach aims to contribute to the broader transformation toward a sustainable, climate-neutral, and climate-resilient society. Furthermore, it offers added value by fostering the development of transformative adaptation options within a transdisciplinary co-production framework. This includes the creation and use of new forms of collaboration, the exploration of emerging fields of action, cross-organizational thinking and decision-making, the systemic understanding of interconnected structures and their adaptation needs as well as the integration of additional relevant stakeholders to address climate impacts.

6 REFERENCES

BMUV: Bundes-Klimaanpassungsgesetz (KAnG) vom 20. Dezember 2023. BGBl. 2023 I Nr. 393 vom 22.12.2023. Bonn, 2023. https://www.recht.bund.de/bgbl/1/2023/393/VO.

European Commission: COMMISSION DELEGATED REGULATION (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives. Brussels, 2021. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2139.

Gehrke, J.-M., Groth, M. and Seipold, P.: A Process Model for Integrating Future-Oriented Climate Information into Business Establishments. GERICS Report Nr. 36. Climate Service Center Germany (GERICS), Helmholtz-Zentrum Hereon. https://doi.org/10.5281/zenodo.14793167. Hamburg, 2025.

Gehrke, J.-M., Groth, M. and Seipold, P.: A process model approach to integrate future climate change into corporate strategies. In: Sustainability Nexus Forum (SNF) 32, 10 (2024), 2024. https://doi.org/10.1007/s00550-024-00550-0.

Pfeifer, S., Bathiany, S. and Rechid, D.: Klimaausblicke für Landkreise. Hamburg, 2021. https://gerics.de/products_and_publications/fact_sheets/landkreise/index.php.de.

Technical Expert Group on Sustainable Finance (TEG): Taxonomy: Final report of the Technical Expert Group on Sustainable Finance. Brussels, 2020a. https://finance.ec.europa.eu/system/files/2020-03/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf.

Technical Expert Group on Sustainable Finance (TEG): Financing a sustainable European economy. Taxonomy Report – Technical Annex. Updated methodology & Updated Technical Screening Criteria. Brussels, 2020b. https://finance.ec.europa.eu/system/files/2020-03/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf.

Schink, A.: Das Bundes-Klimaanpassungsgesetz (KAnG). In: Natur und Recht, NuR (2024) 46, pp. 670–677, 2024. https://doi.org/10.1007/s10357-024-4451-7.

Schuck-Zöller, S., Abeling, T., Bender, S., Groth, M., Keup-Thiel, E., Molitor, H., Sander, K., Seipold, P. and Vilsmaier, U.: Klimakommunikation und Klimaservices (Climate communication and climate services). In Brasseur, G., Jacob, D., Schuck-Zöller, S. (Eds.). Klimawandel in Deutschland. Springer Spektrum, Berlin, Heidelberg, pp. 491-505. Berlin, Heidelberg, 2023.

Völker, V., Ochsmann, M. and Plank, E.: Fit für die interkommunale Klimaanpassung. Rolle und Bedeutung für Landkreise. Deutsches Institut für Urbanistik (Difu); adelphi consult; Zentrum KlimaAnpassung (ZKA). Berlin, 2024.