The shades of adaptation

Individual solutions for each adaptation challenge

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GERICS
Climate Service Center
Germany

An institution of Helmholtz-Zentrum Geesthacht

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Introduction

The Climate Service Center Germany (GERICS) was initiated by the German Federal Government in 2009 as a fundamental part of the German high-tech strategy for climate protection. Since June 2014, GERICS has been a scientific organisational entity of the Helmholtz-Zentrum Geesthacht – Zentrum für Material- und Küstenforschung GmbH.

GERICS delivers scientifically-sound products, advisory services and decision-relevant information to help support government, administration, and business in their efforts to adapt to climate change. We are located in the historic “Chilehaus” in Hamburg and employ an interdisciplinary team of natural and social scientists.

The Director of GERICS is meteorologist and climate scientist Prof. Dr. Daniela Jacob.

The shades of adaptation – Individual solutions for each adaptation challenge

How to succeed in regional adaptation

Developing adaptation strategies or implementing measures to adapt to climate change impacts in a specific region – a metropolitan area, a river basin or a mountainous region – require the consideration of a broad variety of factors and drivers. In addition, a large number of key players such as local administration or businesses have to be included. Independent of the individual scope and strategic objectives, regional to local climate change information is one of the corner stones to estimate possible climate change impacts and the related hot spots in the region under investigation.

During the development of adaptation strategies the following steps have to be kept in mind:

- The climate system is complex. In other words, a change in one component generally results in (often non-linear) changes of other system components such as water levels, wind velocities or air humidity.

- Climate change is a dynamic process with moving targets. This requires flexible solutions that need to be harmonised with existing processes and structures.

- Consulting only one or two climate projections is not helpful, because this could lead to false trends and conclusions. The basis for all adaptation actions should be an ensemble of high-resolution climate simulations of reasonable size (in general more than ten climate projections).

- Climatic drivers are only one part of the story. There are non-climatic drivers such as new socio-economic trends or land-use change, too. Interactions of one or more of these drivers have to be taken into account, all in all leading to potentially very different impacts on the sectors located in the region.

- Possible cascading effects need to be addressed appropriately.

- Adaptation actions can range from short-term to longer-term activities and address different temporal and spatial dimensions.

- There is no “one-size-fits-all” adaptation solution. Each aspect has to be addressed individually. The more precise the question, the more accurate the answer.

Experience gained with case studies, stakeholder consultation processes, interviews, literature analyses and survey evaluations with regard to climate change impacts and associated adaptation measures showed the necessity for a tool that addresses a whole range of actions. This tool needs to be flexible enough to ensure applicability in all regions and scales, independent of their specific settings, such as the environmental framework, the existing degree of information or the pressing

questions. All these requirements are addressed by GERICS' innovative toolkit concept that supports adaptation processes and includes techniques for a systematic assessment of current and future opportunities and vulnerabilities due to climate change impacts.

Currently, three different types of toolkits are under development – a city toolkit, a company toolkit and a regional modelling toolkit. The idea of each of these toolkits is to have numerous independent but easy-to-connect modules, which address different important aspects – e.g. the vulnerability against flooding or the climate change comparability of compensation measures – relevant to represent and to understand the respective systems such as the climate resilience of the critical infrastructure. Depending on the initial question(s), the relevant modules can be selected and combined. One key component included in each of the toolkits is the distilling of all relevant presently available climate information to design tailor-made solutions answering to the requirements of individual questions.

Communication is key

To ensure the best possible (pre-)conditions for the application of the toolkits, efficient interaction, such as the moderation of processes, stakeholder consultations, analysis of needs, improvement of system understanding, the translation of scientific results into practicable knowledge and the transfer of user requirements into science, as well as a lot of transdisciplinary work, provides a solid foundation. All of these actions are part of the module (group) communication. This is essential to overcome the gap between adaptation in theory and in practice, to start the exchange of existing knowledge, to understand needs and associated conflicts, to identify administrative barriers regarding implementation, to build consensus about threats and preferences for adaptation measures between the stakeholders, and to analyse what has been done so far.

The whole process, starting from the development of sound solutions up to the implementation of a measure, is carried out in close cooperation with local stakeholders and experts as well as decision makers in order to combine local knowledge with state-of-the-art scientific climate knowledge.

The process of collecting information starts with a kick-off-workshop together with all necessary stakeholders. At this meeting all participants are invited to describe their needs related to climate adaptation, to list information and data sets needed to answer questions by applying their own methods, as well as to present the available information in the department. In many cases, different actors have collected data others are not aware of. So, very often more information is available than expected. Besides gaining knowledge, this approach supports an integrative view on all relevant aspects to create awareness of synergies and co-benefits, for instance between mitigation actions and adaptation measures. It also allows for solving possible conflicts early along the way.

Flexibility in different scales

Due to the high flexibility of the toolkit-concept it is possible to tailor the toolkit-frame to individual needs: Most modules can be transferred, with some modifications, to almost any other region, city, company, sector or country. However, if such a transfer fails, there is the additional option to co-develop a new customized toolkit-module tailored to the existing framework conditions. The development and proof of applicability as well as the added value of the products are based on a culture of dialogue with the user. The biggest benefit for an entire region can be achieved, if all results gained from the different toolkits are combined in one holistic approach focusing on the different observation scales and fields of action.

Three practice-oriented modular toolkits aim at different scales and topics, in order to meet the

individuality of user needs on a local and regional level (Fig.1). The toolkit that is currently most advanced technically is focusing on urban areas (adaptation toolkit for cities – German product name: Stadtbaukasten). It can be applied in completely different settings: from large cities, which are typically better equipped with human and financial resources and where data availability is better compared to smaller cities, to small municipalities, or rural areas. It concentrates on identifying climate-related hotspots or system weaknesses, and on showing the benefits of adaptation measures. Although companies are part of urban areas, they have a different focus on climate change impacts and adaptation measures. To take this into account, a second modular toolkit (adaptation toolkit for companies – German product name: Unternehmensbaukasten) was developed to support the identification, development, and selection of suitable climate change adaptation measures into relevant business areas. Even though a lot of climate-related information already exists today, there are many cases where appropriate information is missing. To close this gap another toolkit (Regional Modelling Toolkit) is under development and aims at providing the frame for simulating climate change together with its impacts at regional and down to local scale. This includes climate models, impact models and system dynamic models to simulate the changing climatic conditions and their sector-related impacts. Furthermore, the regional influences of multiple stakeholder decisions based on the identification of climate change impacts can be included in this toolkit.

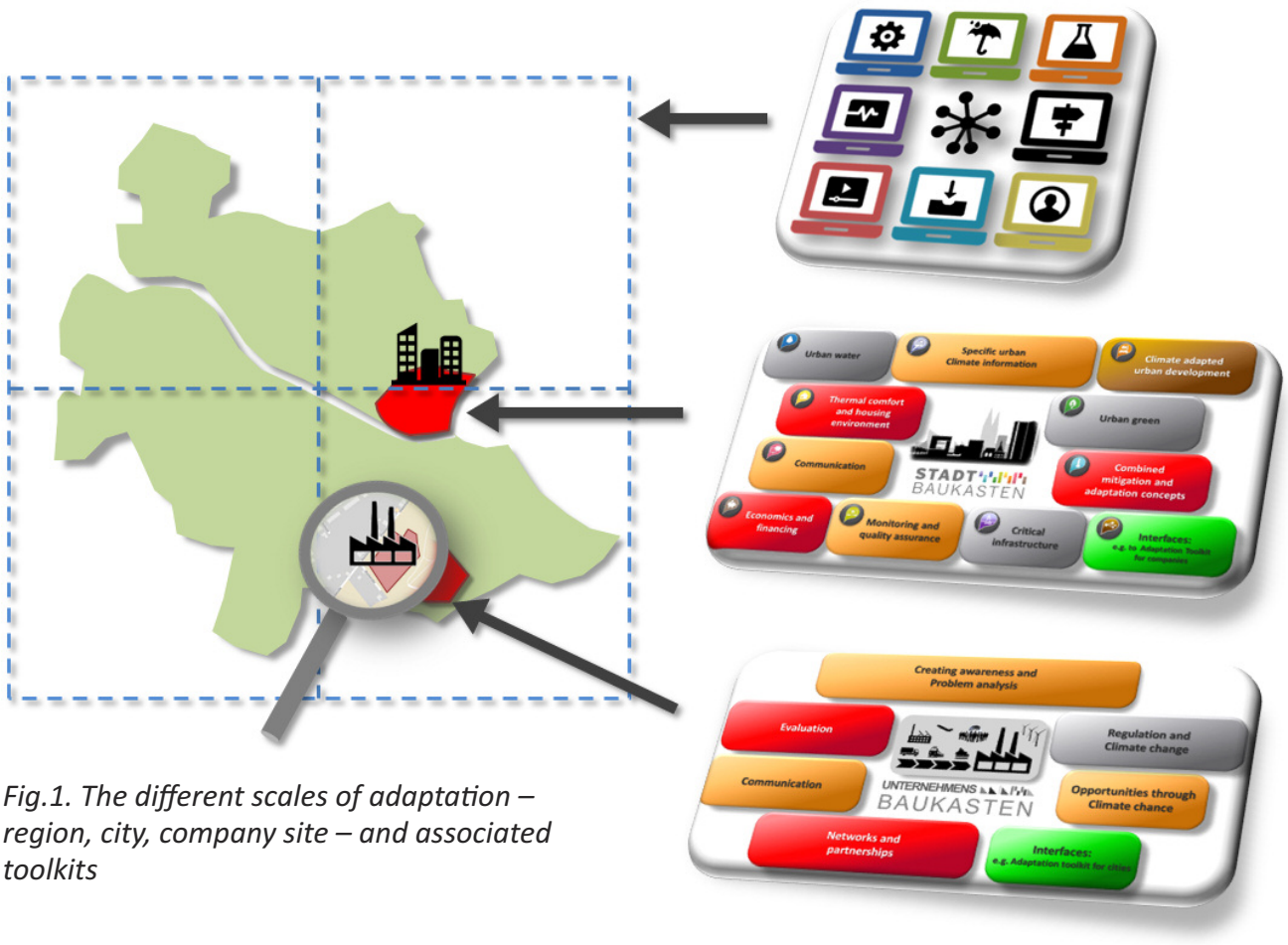

Fig.1. The different scales of adaptation – region, city, company site – and associated toolkits

New challenges for cities and agglomerations

It is widely accepted that mankind has a decisive influence on the changes of global climate. The concentration of people, assets, critical infrastructure and economic activities in urban areas makes cities highly vulnerable to climate change impacts, but also offers opportunities for adaptation. With respect to the development of the climate resilient and sustainable urban regions of the future city planners and city administrations need to consider all kinds of impacts – such as increasing temperature, heatwaves, droughts, river and urban flooding, sea level rise, changing precipitation patterns – and their interactions with other drivers.

In order to identify the specific opportunities and challenges arising from climate change for a city, it is necessary to understand all risks related to climate change throughout the entire urban adaptation process. Therefore, the focus of all related activities has to be on the whole system instead of single elements, to avoid misleading action in sectors that were overlooked or otherwise not considered.

Climate impacts cause considerable stress to the urban population and infrastructure. It is therefore necessary to adapt to local and regional projected climate impacts at an early stage. These impacts need to be considered in planning and design processes to positively influence the quality of life and the resilience of infrastructure in the future.

Urban areas are key players with respect to climate change. They are not only contributing to climate change, they will also be affected by expected climate change impacts. Therefore, it is necessary to consider mitigation and adaptation jointly and equally when searching for solutions. Even though effective adaptation measures are known, such as the preservation and expansion of green areas and water elements or the use of climate-sensitive construction materials, there is often still a gap between the approaches in theory and in practice due to administrative barriers and a lack of understanding.

The first step when applying the "Stadtbaukasten" is the analysis of all site characteristics. This includes environmental developments, administrative processes and regional climate information of past, present and future.

The modular setting provides a general framework and allows a flexible application. Despite the fact that flexibility is not per se an adequate methodological approach to deal with complex systems, it here refers to the possibility for decision-makers to pick and choose those tailored elements of the framework that fit best to their needs. In case there are no modules available that address the topics raised, new modules can be developed to meet the demand.

The GERICS-Stadtbaukasten provides eleven module groups that cover the most important fields relevant for cities to plan, develop and implement adaptation actions, such as urban water, urban green, climate-resilient urban development or critical infrastructure. Within each module group, one can find one or more modules with specific priorities (see Fig.2)

Adaptation in the complex context of urban areas

Adaptation actions in urban areas are not easy to implement. Due to the impacts of cross-cutting climatic and non-climatic drivers, numerous dependencies and interactions between different sectors exist. Many stakeholders are involved, each representing different interests, and thus the adaptation approaches need to address the different needs in a balanced way. A further challenge is the transfer of scientific state-of-the-art knowledge into practice (see Box on p.8).

Fig.2. A look inside the “GERICS-Stadtbaukasten”. What is the story behind the module groups “Urban water” and “Urban green”?

Despite the complex setting, local councils are key actors when it comes to the development, implementation and monitoring of adaptation strategies and respective measures. They are embedded in a complex framework that is influenced by legislation, conflicting interests of administrative units, limited financial and human resources, urban-rural relationships, cultural habits, and operational capability. It is in order to best address this complexity, that the adaptation toolkit for cities currently consists of modules organized in so-called module groups.

Experience shows that the most important module group when working with cities is “communication”. All modules inside aim to raise awareness of local weaknesses and hot spots, to involve all relevant stakeholders such as representatives from different local authorities or from the private sector, and to stimulate the dialogue between all partners.

With respect to the high number of existing administrative procedures and legally prescribed processes the use of this toolkit is designed in a way, that all operations can be integrated into existing process chains. As additional benefit the modules can be used as a bridge between two or more workflows – such as environmental assessments and the development planning process – creating and making use of available synergies. This function helps to reduce additional administrative efforts and it decreases the barrier for acceptance facilitating adaptation action in general. This is of utmost importance since in many cases adaptation activities compete with activities in other sectors such as educational and cultural services.

Lessons learnt from the co-development process at the interface of theory and practice:

- New applications have to address actual needs.
- Applications have to fit in existing decision-making processes.
- Needs articulated by stakeholder are sometimes fuzzy and might change during adaptation processes.
- Restricted human, financial, and information resources are limiting factors.
- The focus on one sector is usually not sufficient to tackle adaptation issues.
- The development of an adaptation strategy is not the end, it is the beginning of taking an in depth adaptation action.
- The hardest step for the adaptation process is the implementation into daily business.

Adaptation as a competitive advantage

Even before growing globalisation, seafaring trade had to deal with the weather as an integral part of its business. Today, as value chains get complex and supply chains are global, business can be influenced more often by weather, for instance by extreme events, such as river and coastal flooding, heavy rain events, droughts or heatwaves (Fig.3). Yet, only few companies already carry out climate assessments, or use tools or models to assess their risks related to extreme weather events or future climate change impacts. However organisations can benefit by taking action to recognize such climate related risk and even anticipate corresponding events. There are five different kinds of risks in this context:

- **Physical risks:** related to damage on infrastructure or supply-chain operations
- **Price risks:** increased price fluctuations of raw materials and other commodities
- **Market risks:** core products become unpopular due to new alternative technologies/developments; changes of consumer behaviour
- **Regulation risk:** as a reaction of changing national and international climate-policies (adding costs or withdrawal of subsidies)
- **Reputation risk:** profitability loss due to activities or positions that the public considers harmful.

Supporting companies with respect to these risks to cope with climate change impacts is quite different compared to cities. The motivation of cities is focused on security needs and risk prevention, whereas companies are more focused on business opportunities. A proactive analysis with climate change impacts opens up chances for new business models or products. Still, businesses struggle with the development and implementation of climate-proof strategies. Bringing together corporate strategy planning and adaptation issues is problematic, due to the different periods under consideration. Whereas strategic planning rarely exceeds three to five years, the risks of climate change impacts will manifest themselves only within several decades. Nevertheless, to do nothing will prove to be expensive in the long-term.

Cities and businesses share the necessary individuality of adaptation measures. Since every business component is affected by different climate impacts in a different way, tailored methods have to be used here, too. As a fundamental principle all developed solution strategies are based on the latest available, state-of-the-art scientific knowledge. A partnership-based cooperation concept ensures

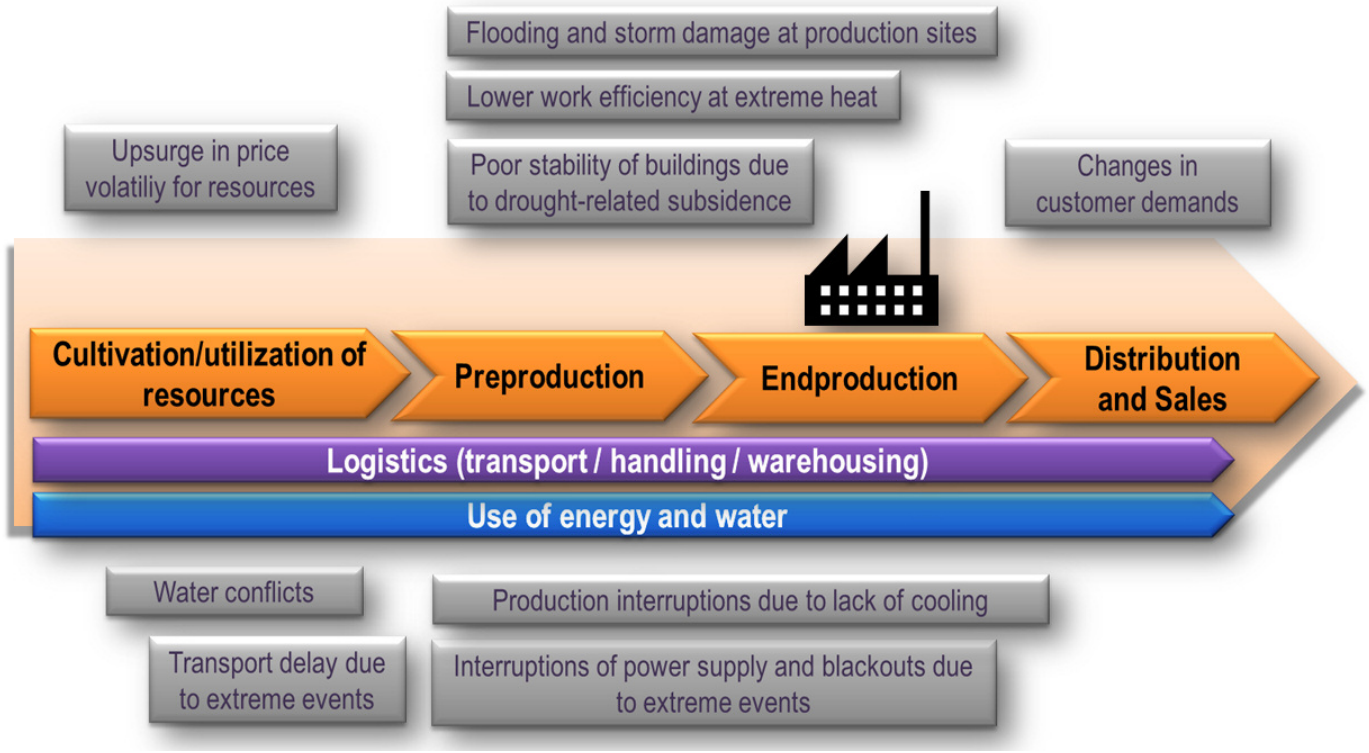

Fig.3. Examples of multiple challenges due to climate impacts along a value chain

that products meet all requirements perfectly. Understanding the opportunities and risks of climate change and quantifying the impact are crucial to develop strategic measures for adaptation.

Creating awareness and a problem analysis are important starting points towards adaptation. Both need to use state-of-the-art climate science information with a focus on the identification of areas of vulnerability within the value chain. The idea behind this is to find the trigger for thought-provoking impulses. This could range from the planning and implementation of redundant system elements up to the relocation of suppliers and/or industrial facilities away from highly exposed sites.

The role of GERICS is to act as a catalyst introducing customized scientific knowledge to match a company's internal expertise. Interlinking the two subsequently enables a company to channel adaptation measures fit for its very own specific purposes. Thus, the "Unternehmensbaukasten" provides an innovative instrument to benchmark a company's adaptation strategy to climate change against peers.

Scientific mirror images for individual regions

Regional climate information – in combination with other regional or local information – is the key to successful adaptation. In order to investigate the complex interactions between the different components of climate, soil, water, land use, human factors or ecosystems services it is necessary to find the right combination of existing models being able to answer specific

questions arising in a specific region. Accordingly, analysis methods can be numerical. Even in this approach the chosen method is driven by the individual needs. These differ depending on the region, its environmental framework, the potential impacts and drivers as well as the region's size. To be able to address specific questions the modelling approach has to be individually tailored. Sometimes, even a simple component is sufficient, e.g. representing a city in a regional model only by the parameter "land surface property". In complex cases, a whole "model group" is necessary. In the example of the city, e.g., the heat island effect or pollutant emissions can be additionally taken into account. This also has effects on the interactions between the components.

For this purpose, a "Regional Modelling Toolkit" is under development combining the well-known methods to model regional climate change signals and the resulting impacts using regional climate models, hydrological models, integrated assessment models, cost-benefit-analysis tools, and many more, with a system dynamics approach. This combination supports the understanding of the non-linear behavior of complex systems over time. The results can be used to frame, understand and discuss complex problems.

In essence, the components relevant for a region are simulated and linked with each other. The toolkit facilitates the identification of the most appropriate combination of models with the following aims:

- Analyse the impacts of climate change in a region by linking all essential components.
- Support science-based decision making based on local information with state-of-the-art science.
- Support decision-makers to better understand the complexity of sustainably managing a region.

With regard to smaller sub-sections of a region – such as urban areas or company sites – the gained knowledge can also be used as a basis for the development of adaptation strategies and action on the smaller scale combined with governmental legislation or company goals. This way, results of the Regional Modelling Toolkit can be included in modules of the adaptation toolkit for cities or the company toolkit.

Adaptation in theory and in practice

As simple as adaptation to climate change can sound at the beginning, as difficult it becomes when working on it. Adaptation to climate change is a complex process, requiring the synthesis and integration of different approaches, methods, tools and stakeholder engagement. The potential for effective climate risk management, and thus adaptation, is increased by considering both climate and non-climate factors as well as different scales of potential risks.

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