

AACHENER GEOGRAPHISCHE ARBEITEN
Heft 50

Herausgegeben von:
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Global Demographic and Climate Challenges in the City
An interdisciplinary assessment of impacts, needs and strategies

Herausgegeben von:
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GEOGRAPHISCHES INSTITUT DER RWTH AACHEN
IM SELBSTVERLAG
2013

ISSN 0587-4068
AGA RWTH AACHEN

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2013

Geographisches Institut der RWTH Aachen im Selbstverlag

Druck: Digitaldruck AixPress GmbH

Printed in Germany

Titelseite

Gestaltung: Hans-Joachim Ehrig

Foto: T. Sachsen/M.Buttstädt 08/2010[®], SuperC/Bergbaugebäude RWTH, Aachen, Wüllnerstraße

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The vulnerability assessment within *dynaklim* - a tool for analysing the effects of climate change on enterprises

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Managing the impacts of climate change is an important issue for sustainable urban planning. A large range of economic activities influence urban climate and are influenced by climate change itself. The impacts of climate change on power plants, manufacturing processes and business locations as well as adaptation options should be analysed to understand the vulnerability to climate change. The seriousness of the potential impacts of climate change on enterprises requires new concepts and innovative products for flexible and robust adaptation options. The analysis of the impacts of climate change on enterprises and potential adaptation measures is the basis of the research framework of a “climate-focused economic development” within the networking and research project *dynaklim*¹. A differentiated vulnerability assessment enables us to define and identify strategies of adaptation in the means of organisational, market-focused and technical developments.

1 Industrial sectors and climate change in the *dynaklim* region

This paper provides an overview of the method of vulnerability assessment which was developed within the networking and research project *dynaklim*. The *dynaklim* project carries out multi-disciplinary research on dynamic and anticipating adaptation options in the Ruhr region. The main objects of the research are reducing risks for inhabitants, enterprises and infrastructure to climate change related impacts, with special focus on the regional water balance.

The Ruhr region is one of the five largest conurbations in Europe and is home to approximately 5.2 million people. The project region encompasses 52 cities and municipalities. Over decades, the region has transformed itself from a coal and steel industrial site to a service- and culture-oriented metropolis. Generally, the importance of the manufacturing is declining; however, certain industries (e.g. metal industry, chemical industry, mechanical engineering, electrical engineering & measurement and control technology) still play an important role in the *dynaklim*-economy and the region. It is also worth mentioning that in the course of structural change, the tertiary sector is still not able to compensate all the jobs that were lost in the primary and secondary sectors. During the current decade,

1 *dynaklim* - Dynamic Adaptation of Regional Processes to the Effects of Climate Change in the Em-scher-Lippe Region (North Rhine-Westphalia, Germany); financed by the German Federal Ministry of Education and Research (www.dynaklim.de)

a negative balance of about 70,000 employees with social security number (SSN) can be observed.

Figure 1² shows an attribution of the absolute SSN data (bubble size) to the various economic sectors in the *dynaklim*-region in 2008. Additionally, the sector-specific dynamics of the SSN (X-axis) between the years 2000 and 2008, and the region-specific perceptibility/localisation quotient³ (Y-axis) are shown.⁴

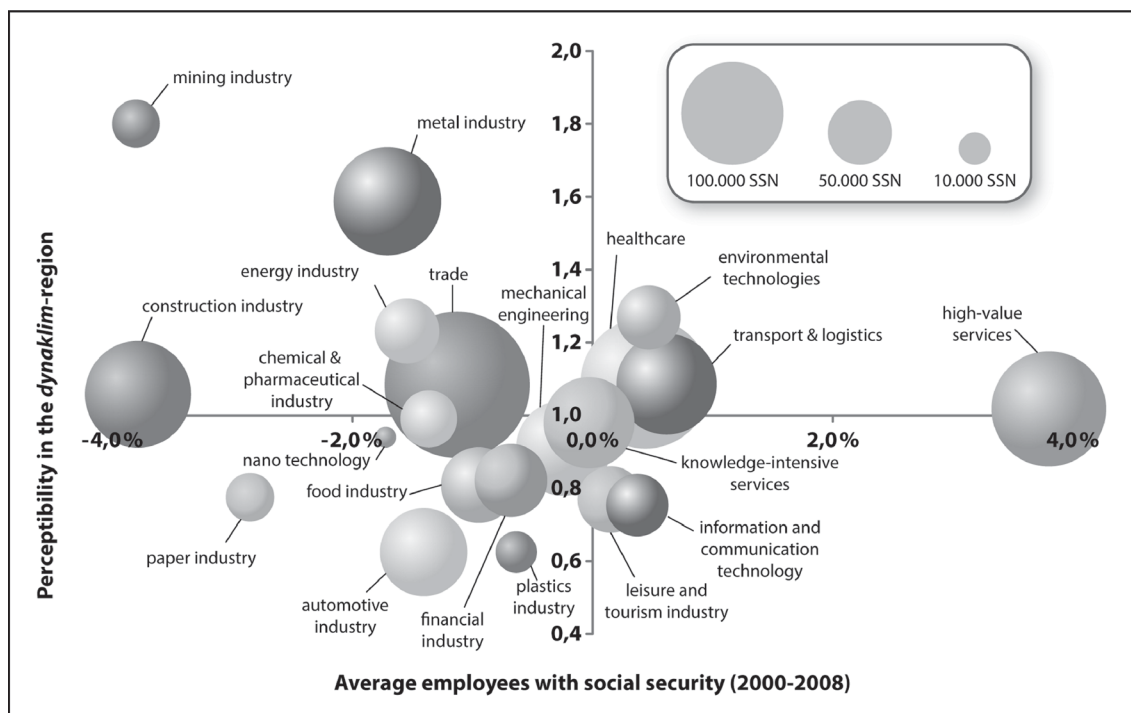


Figure 1: Industrial sectors according to the German classification of economic activities (WZ 2008) and employees with social security; Source: Lühr/Apfel/Schneider (2011a)

Within the *dynaklim*-project only those economic sectors were chosen for the vulnerability assessment, which have already been reviewed by other scientific research (see chapter 2.1) and are characterised by a high regional significance. These two conditions were

- 2 The illustration is based on the industrial sector classification of the Federal Statistical Office (Statistisches Bundesamt) from 2008 at the level of the German classification of economic activities (WZ 2008), and SSN data for the *dynaklim*-region for the years 2000 and 2008 are based on data of the Federal Employment Agency (Statistik der Bundesagentur für Arbeit).
- 3 The localisation quotient is a measure of the concentration and specification of an industry in a region (here: the *dynaklim*-region) compared to a higher-level region (here: the State). If the localization quotient is 1, the industry in the region is equally well represented than in the higher-level region. Values greater than 1 point to an over proportional frequency of the industry, values less than 1 to a below average frequency of the industry in the region.
- 4 A primary analysis is not carried out in the vulnerability assessment within *dynaklim*. The assessment is based on data provided by the Federal Statistical Office (Statistisches Bundesamt) the Federal Employment Agency (Statistik der Bundesagentur für Arbeit) and scientific statements on adaptation options and market changes referring to climate related risks (see chapter 2.1).

considered as basic requirements for a comprehensive comparability of the economic sectors within the *dynaklim*-region.⁵

According to long-range climate forecasts⁶ summer in Western Germany will become hot and dry with recurring events of extreme rainfall, while the winter season is expected to be more wet and moderate, as compared to now. This change of the climate conditions will have lasting effects on the socio-economic conditions of the population regarding water security, quality and costs, and regarding the region's productivity and competitiveness. The following impacts of climate change predicted for the project region:

- *Storms will cause more damages in future:* The severity of storms will increase and extreme weather events are likely to occur every 10 years. Damages caused by storm and hail will increase by 10 % in medium-term (2011 - 2040) and 30 % in long-term (2041 - 2070). During the summer months, an increase up to 20 % (2011 - 2040) and 60 % (2041 - 2070) is possible.
- *Rainfall will rise in amount and intensity:* Models show that an increase of heavy rainfall (4 - 5 days per year) is likely to occur in the project region. The financial loss caused by flooding and flash floods might be doubled by the end of the century (1961 - 2000: 500 million Euro).
- *Increasing periods of heat will be a problem mainly in metropolitan areas:* The annual average temperature will rise by 1.9°C in the long-term. The summer period will generally be drier and heat waves will occur more frequently and last longer. Soil-sealing, missing fresh air corridors and a lack of areas for evaporation lead to heating of buildings and districts.

First impacts of climate change in the project region can already be proved, such as the heat waves in the summer of 2003 and 2006 and heavy rain falls in the cities of Dortmund, Bottrop, Essen, and Oberhausen in 2008, 2009 and 2010. Further developments of these trends are expected for the upcoming decades⁷.

2 The Vulnerability Assessment

The vulnerability of a system is reflected by the exposure and sensitivity of that system to hazardous conditions and the ability, capacity or resilience of the system to cope, adapt or recover from the effects of those conditions⁸.

5 The great share of scientific literature doesn't provide sector specific information. Detailed analysis on the impacts of climate change on economic sectors are only available for the chemical & pharmaceutical industry, the energy industry, the metal industry, transport & logistics, tourism, the construction industry, high-value-services and agriculture & forestry.

6 PIK 2009; MUNLV 2009

7 PIK 2009; MUNLV 2009

8 SMIT/WANDEL 2006

Taking the opportunities and reducing the risks associated with the effects of climate change corresponds with the ability to adapt to climate change.

The analysis of the vulnerability of the economic sectors of the *dynaklim*-region takes a three-stage model into account (Figure 2). The three-stage model was chosen to determine the framework of research (stage 1), to assess the climate related impacts in the dimensions of risks and opportunities (stage 2) and to evaluate adaptation options of enterprises within the *dynaklim*-region (stage 3).

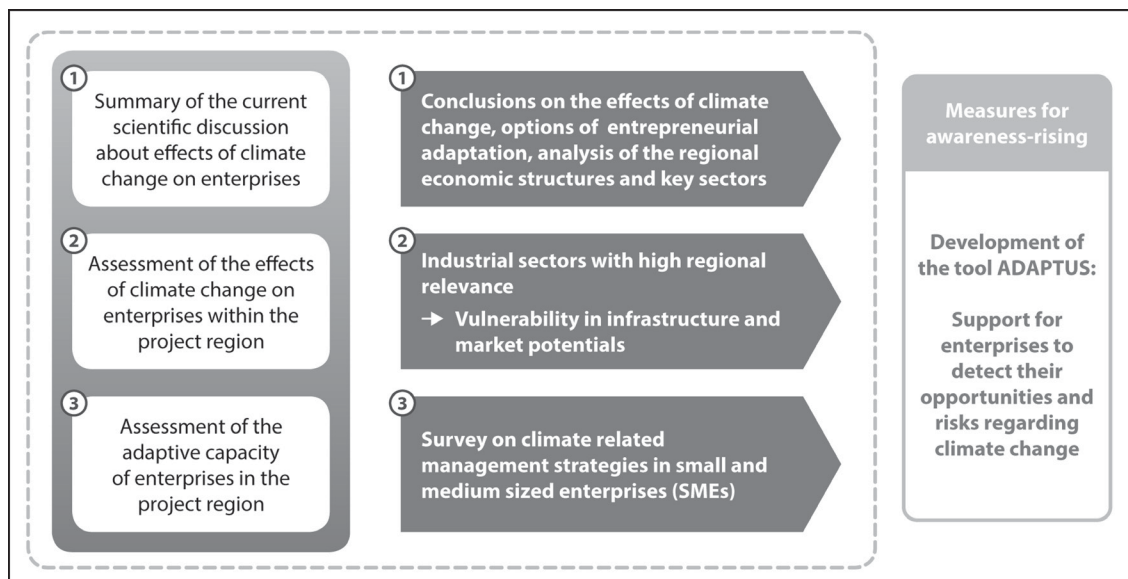


Figure 2: Method of the Vulnerability Assessment; Source: NIES/APFEL (2011)

2.1 Vulnerability Assessment – Stage 1 (VA I)

The first part of the vulnerability assessment summarises the current scientific debate on climate related impacts on the regional economy. This analysis of national and international literature builds the basis for a subsequent assessment concerning the economic sectors represented in the *dynaklim*-region⁹.

VA I focuses mainly on the following two issues:

- basic statements on risks, opportunities and the adaptive capacity of industrial sectors with respect to the impact of climate change,

9 The analysis was designed by the following categories: impact of climate change on enterprises in the field of business location, infrastructure, factor allocation, value chain, technologies, market potentials. Further more adaptation options, the innovative strength and the general legal framework were taken into account in VA I.

- appropriate criteria and indicators to assess climate related vulnerability and adaptive capacity.

The literature and source analysis of the *dynaklim* working group “climate-focused economic development” is based on approximately 70 selected national and international studies. In addition to the scientific debate differing perspectives were considered to result in a broader picture. With regard to a regional assessment region-specific information was taken into account such as reports and studies of industry associations, cluster initiatives and enterprises.

The results of the review present detailed knowledge of the economic sectors in the *dynaklim*-region. VA I emphasises the main climate related impacts expected in the economic sector. The further analysis of VA II concentrates on the impacts in infrastructural systems and market potentials, due to the fact that in the *dynaklim*-region impacts in factor allocation and value chains are less exposed to climate related risks. Business locations are determined by unique characteristics and therefore unsuitable for comparison in such a large project region. A summary is given in the following table:

Field of impact	Factor allocation	Value chain	Business location	Infra-structure	Market potential (technological supply)	Market potential (consumer demand)
Industrial sector						
Agriculture & forestry	xxx	x	xxx	xx	x	x
Manufacturing and proceeding industry	x	xx	x	xxx	xxx	xxx
Energy industry	x	xx	xxx	xxx	xxx	xxx
High-value services	x	x	x	xx	xxx	xxx
Tourism	x	x	xx	x	x	xx

Impact: x = no or little impact, xx = medium impact, xxx = significant impact

Figure 3: Field of impact according to industrial sectors; Source: LÜHR/APFEL/SCHNEIDER (2011a)

2.2 Vulnerability Assessment - Stage 2 (VA II)

Infrastructural systems are stated to bear the highest risks of climate change. The supply and transport infrastructure are the backbone of the economic production; hence, the transport, water and energy systems are considered to be the most vulnerable sectors in

enterprises. The delivery and removal of goods and production processes depend on fully functioning infrastructural systems. First priorities are given to strategies and measures which address the transport, water and energy sectors¹⁰.

In general the influence of climate change on production processes, business locations of enterprises and industrial sectors can open diverse opportunities on international markets. Economies and societies suffering from climate related impacts will increasingly request products to adapt to the impacts of climate change. In order to cope with this demand it is necessary to either find intern technological solutions, or to import technology and high-value services from experts. Dealing with climate change requires innovative products, processes and new forms of organisation. Different options for adaption are most likely to be introduced by other industrial sectors than those, who are directly affected. The planning, development and launch of new products and services for adaption are associated with the same or even greater uncertainties as in all other market segments. Evidence for the development of a distinct product market for adaptation may thus not be given¹¹.

Figure 4 shows the results of the detailed assessment of climate related chances and risks of selected economic sectors in the *dynaklim*-region. The vertical axis displays the infrastructural independence of the economic sectors; the x-axis displays their market potentials. Sectors with very low dependency on infrastructural systems and high market potentials, such as high-value services, mechanical engineering and the construction sector will benefit most from climate related impacts. Economic sectors, which are already highly dependent on infrastructural systems and show significant deficits in market potentials, are most likely to face economic threats. Without specific strategies they will hardly be able to cope with climate change in their businesses.

Although the assessment shows existing differences between the various industrial sectors (Figure 4), the analysis of the vulnerability, based on a sectoral approach, is limited. Precise information on the state of economic vulnerability can only be given, if the specific individual situation of the enterprises is taken into account. This means that an assessment of vulnerability cannot be conducted only in a sectoral scope, but requires individual considerations as well. Potentials and skills to take a foresightful action and to deal with climate related risks are strongly dependent on the company's corporate culture and the personal perception by a company's management. This importance of adaptive capacity is taken into account in VA III.

10 HEYMANN 2007, MAHAMMADZADEH 2009, Helmholtz-Zentrum für Umweltforschung – UFZ 2008, KPMG 2009, OTT 2008, Bundesministerium für Wirtschaft und Technologie 2010, Institut für ökologische Wirtschaftsforschung 2009

11 HEYMANN 2007, Institut für ökologische Wirtschaftsforschung 2009, MAHAMMADZADEH 2009, Helmholtz-Zentrum für Umweltforschung – UFZ 2008, PIK 2009

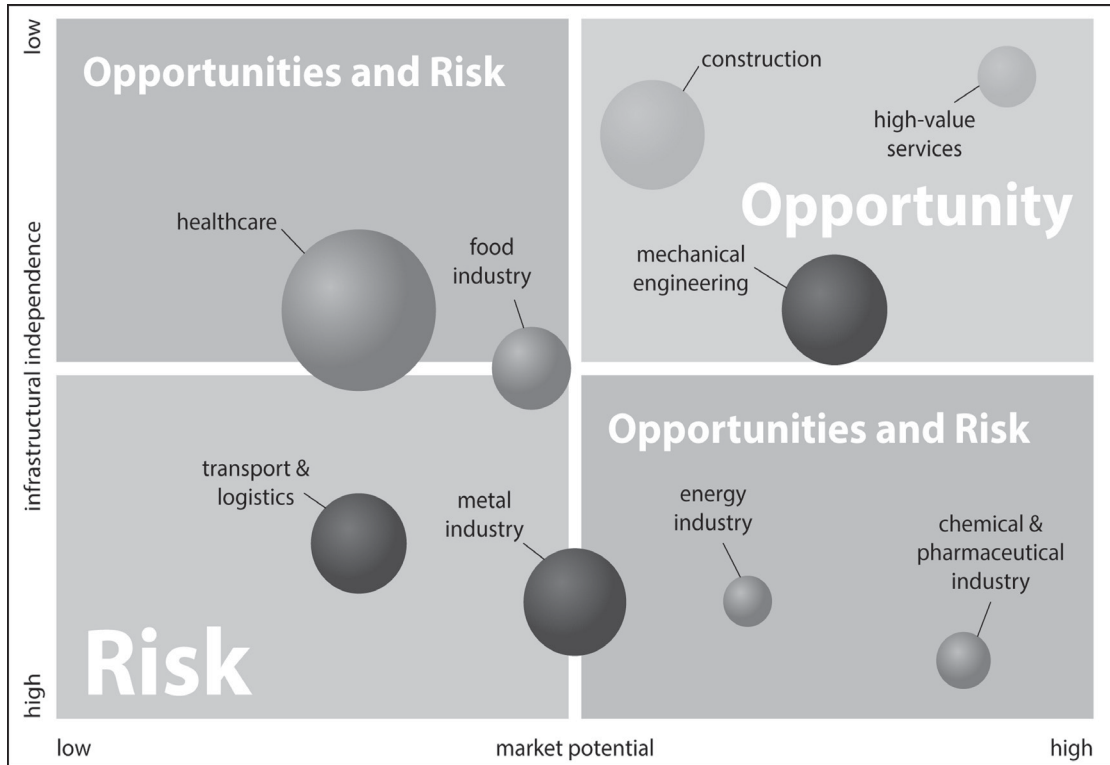


Figure 4: Impact on selected economic sectors in the dynaklim project region; Source: LÜHR/APFEL/SCHNEIDER (2011a)

2.3 Vulnerability Assessment - Stage 3 (VA III)

The aim of VA III was to identify the status quo of the adaptive capacity in the enterprises of the *dynaklim*-region. The results of VA I and VA II were supplemented through a qualitative analysis. A survey on climate-related management strategies in the manufacturing and proceeding industry in the *dynaklim*-region was conducted by individual telephone interviews. The central questions which were explored concerned on companies current measures of adapting to climate change, the possibility to cope climate change with strategic management systems and chances for new markets emerging from climate change.

Out of a sample of 500 SMEs of the manufacturing and processing industry in the project region¹², a focus group of 60 enterprises was selected¹³. From this group, another 30 companies were selected and detailed telephone interviews were carried out in order to gather

¹² SMEs of the manufacturing and processing industry were chosen because they represent 99,5% of the economic activities within the project region (see IfM Bonn 2011).

¹³ The selection of the interviewees was not made according to the criteria of representativeness; therefore, no random sample is based. The main interest was seen in rather typically cases, so that potential interviewees were contacted directly (see LAMNEK 2005).

information on their companies. In this regard, primarily the management or employees who are concerned with environmental and quality management were addressed.

The results show, that:

- General information on climate change is available to enterprises. The basic information is thereby disseminated by the public media. Nevertheless, there is a demand for business-related and region-specific information. Business associations and chambers are popular information providers. They are particularly suited to lead the dialogue of adaptation to climate change.
- Enterprises perceive climate change only if they are already exposed to impacts of climate. Enterprises that are not located close to rivers or in low grounds expect no impacts in short to medium term.
- The general climate-related vulnerability of an enterprise is mainly seen in the field of infrastructure, such as transport, water and energy. The energy sector is a key factor for the production.
- Extreme weather events, especially heavy precipitation, heat waves and storms may have negative impacts on the value chains.
- As a part of their strategic management, enterprises already implement various measures of adaptation to deal with the impacts of climate change. These activities, however, mainly focus on energy and resource efficiency, as well as mitigation.
- Measures which are already taken are implemented by existing quality and environmental management systems. Therefore these management systems should be addressed to support adaptation in enterprises.

In summary it can be emphasized, that the adaptation to climate change is generally not new for the enterprises in the *dynaklim*-region. A significant disparity can still be seen. The topic is dealt with very selectively, a real field of action may not be identified yet. Other current megatrends, such as resource efficiency, demographic change and socio-economic developments, are the main focus of enterprises, which is why adaptation is given less importance. If adaptation is addressed in enterprises, they deal with actions to keep the costs low, in case of process-interruptions and damages. Knowledge about climate change exists, however, a distinction between adaptation and mitigation does not take place. This is due to the fact that measures are mainly implemented in energy efficiency which refers to climate change as a whole and to mitigation. A need to distinguish between adaptation and mitigation is not seen at all, neither by external stakeholders nor by the enterprises actors.

The importance of adaptation to climate change is well recognised by employees working in the field of environmental management. Adaptation is always depending on the initiative of a few actors. Therefore awareness raising in the management levels may succeed, if it addresses the responsibility of environmental management. Compulsory rules for

adaptation, regulatory incentives and entrepreneurial models and strategies in the field of adaptation are stated to accelerate the process of adaptation to climate change in companies.

3 Conclusion and further actions

The current scientific debate on entrepreneurial adaptation to climate change states the existence of uncertainties regarding the influence of climate change on the region, the specific economic sector and the enterprise itself. It is also stated that there is an individual exposure of economic sectors to various impacts of climate change, which is underlined by the results of the vulnerability-assessment.

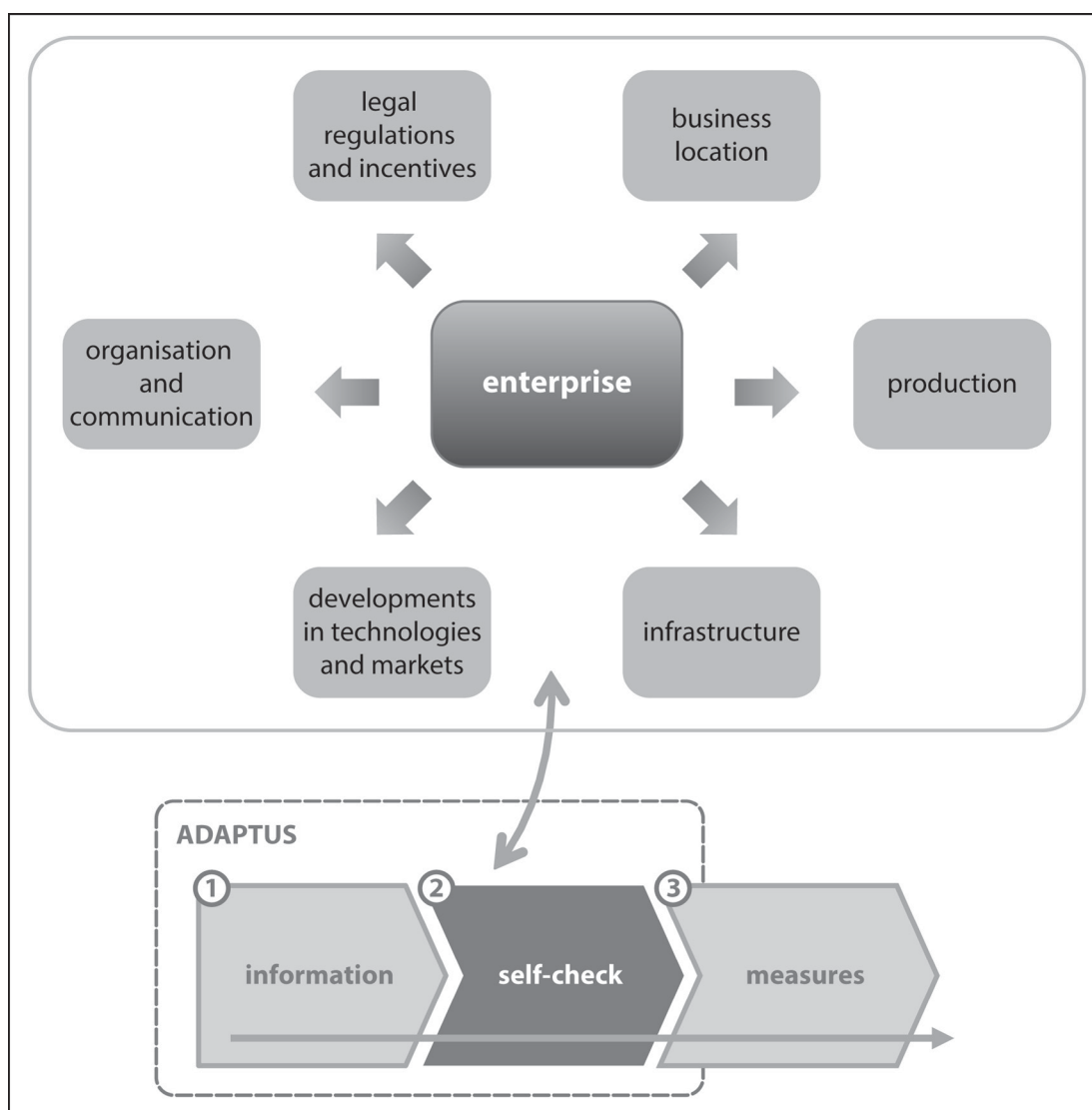


Figure 5: ADAPTUS; Source: own research

At the same time, however, enterprises do not investigate in adaptation measures due to missing information or difficulties in accessing information. In most cases, enterprises miss location-based knowledge, which would support them in dealing with the impacts of climate change.

Besides the adaptive capacity of enterprises there is a great significance of mainstreaming the topic. Networking and information events will play an important role in the future. Dialogue and information sharing, as an interactive process, will raise awareness of enterprises in the means of climate related impacts. Adaptation measures will be best developed and recognised by enterprises if they are linked to practical tools, e.g. management tools of the environmental management, and best-practise examples of enterprises already dealing with climate related impacts are given.

An important role towards such a development lies in awareness-raising in the region and specific offers for the target group. Within *dynaklim* this approach is met by the development of a specific adaptation tool for enterprises – ADAPTUS (Figure 5). The tool is based on already existing instruments in the field of adaptation measures, such as Klimatolse (UBA), climate resilience toolkit (Defra UK), UKCIP Adaptation Wizard (UK) and EUKASKOP (Klimzug-NordWest 2050).

The aim of the tool ADAPTUS is to provide a quick and unbureaucratic target-oriented test, aligned with a set of indicators, which enables the decision-makers in enterprises to assess their vulnerability. After this initial self-assessment, first recommendations are developed to support the enterprises in specific entrepreneurial adaptation measures.

The tool ADAPTUS is divided into the following three steps:

- **Step 1 *Information*:** Providing information is the basis for awareness raising on climate change in enterprises. Lack of information regarding the own challenges in climate change and missing detailed information are the main barriers for adaptation in SMEs. The main focus of the step “information” is to provide information on external factors, which cause climate related risks within the company’s region, such as risks regarding the business location and infrastructure.
- **Step 2 *Self-Check*:** A structured risk analysis detects the main challenges of an enterprise due to climate change. Indicators address different categories in an enterprise, such as its location, infrastructure, organization and communication, supply-chain-management etc. On the basis of these indicators, an assessment of the own vulnerability can be conducted.
- **Step 3 *Measures*:** Based on a prioritisation of actions *measures are developed* by the enterprises, assigned to corresponding divisions and personal responsibility, and integrated in the business strategy. The *measures are implemented* according to the provision of financial and human resources. The integration in the organisational structure or an adjustment of it must be guaranteed to enable the implementation. A systematical reviewing and comparison of target and actual figures (*evaluation of*

the measures) combined with a regular self-assessment with ADAPTUS ensures the success of the measures taken to adapt to climate change.

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