Sino-German Urbanisation Partnership

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

CLIMATE RISK MANAGEMENT IN CITIES

KEYSTONE PAPER 4

Sino-German Urbanisation Partnership

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

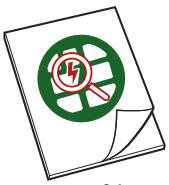
of the Federal Republic of Germany

This document is part of five keystone papers looking at current emerging topics in the building and city sector, focusing on energy efficiency and resilience. The keystone papers were developed within the framework of the Sino-German Urbanisation Partnership as a basis for the forthcoming working period and cover following topics:

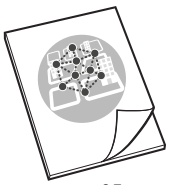
01
Plus Energy Buildings and Districts

02
Energy Efficiency of Buildings and Districts in Urban Renewal

03
Transformative City



04
Climate Risk Management in Cities



05
Urban Renewal in Districts

Prepared by:

BURO HAPPOLD ENGINEERING

Happold Ingenieurbüro GmbH
Pfalzburger Straße 43-44
10717 Berlin, Germany

CONTENTS

LIST OF FIGURES

ABBREVIATIONS

ACRIplus	Advancing Climate Risk Insurance Plus
APA	Adaptation Action Plan
BauGB	German Building Code
BMU	Federal Ministry of the Environment, Nature Conservation and Nuclear Safety
DAS	German Strategy for Adaptation to Climate Change
DRM	Disaster Risk Management
EU	European Union
EnEV	Energy Saving Ordinance (Energieeinsparverordnung)
ExWoSt	Experimental Housing and Urban Development Programme
GHG	Greenhouse gas
IBA	International Architecture Exhibition
ICRM	Integrated Climate Risk Management
IKI	International Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
KLIMZUG	Making Climate Change Sustainable in Regions Programme
MCII	Munich Climate Insurance Initiative
NKI	National Climate Initiative
REGKLAM	Regional Integrated Climate Adaptation Programme for the Dresden Region
SSD	Smart Sustainable Districts
UN	United Nations
WSVO	Thermal Insulation Ordinance (Wärmeschutzverordnung)

0. EXECUTIVE SUMMARY

Globally, cities account for about 70 % of global greenhouse gas (GHG) emissions. Also in Germany, cities are emitting a large proportion of the country's carbon footprint, while being especially prone to be affected by the impacts of climate change. In urban environments, increased frequency of extreme weather events, including storms, flooding or heat waves, can have severe physical, economic and social impacts. To create climate resilient cities, therefore, municipalities need to follow a two-legged approach, taking both mitigation and adaptation measures into account.

For GHG mitigation, main actions in German cities include minimising the energy demand of buildings, decarbonisation of the mobility sector, and improvement of land use planning regarding compact settlement planning. To address the challenge of climate adaptation, it is crucial that municipalities develop comprehensive adaptation strategies, and integrate them into their existing urban development plans. To identify risks and establish targeted action plans, climate risk analyses are crucial to provide for informed decision-making and cost-benefit overviews. They integrate existing climate data and projections, while also taking into account environmental aspects, and socio-economic challenges. The full spectrum of Disaster Risk Management (DRM) in cities, however, also includes implementation of prevention measures, preparation and response during, and after emergencies, and involves a variety of stakeholders on several administrative levels.

Municipal climate policy is strongly influenced by frameworks and strategies of the United Nations (UN), the European Union (EU), as well as German Federal and subnational administration. Other organisations such as the Association of German Cities, further influence municipal climate policy. The most important policy frameworks of Germany's Federal Government is the German Strategy for Adaptation to Climate Change (DAS) of 2008, the Adaptation Action Plan (APA) I adopted in 2011, and the progress report on adaptation, also including APA II, further detailing timeframes and finance plans in 2015. According to APA II, the six main fields of climate action are water, land, infrastructures, industry, health as well as regional planning and civil protection. To identify risks and potential hazards related to climate change in Germany, the Federal Government established the Vulnerability Network, a research consortium comprising of several federal agencies and scientific experts. Since introduction of DAS and APA, until 2017, around 90 % of all German municipalities with more than 100,000 inhabitants have developed either full adaptation strategies or integrated activities with a climate-related focus in their development plans. Since the 2011 update of the German Building Code (BauGB), municipalities are required to consider integrated adaptation strategies for land use planning and infrastructure development.

The Federal Government offers a number of programmes supporting measures for climate mitigation and adaptation. The Programme for Adaptation to Climate Change of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), funds projects specifically targeting adaptation, including concept development, educational programmes, and flagship projects. The Making Climate Change Sustainable in Regions Programme (KLIMZUG), provided financial assistance between 2008 and 2014, targeting the development of adaptation strategies in seven model regions. BMU's National Climate Initiative (NKI) is another support programme focusing on both mitigation and adaptation strategies and projects for public and private stakeholders. While NKI focuses on projects within Germany, BMU's International Climate Initiative (IKI) targets developing and emerging economies.

To reduce risk of climate impacts in urban environments, the emerging concept of so-called Sponge Cities is a form to increase urban resilience through establishment of decentralised green infrastructure. Based on the principle of decentralised rainwater harvesting, it supports the natural water balance through integration of precipitation, evaporation, increase and reduction of water levels in urban development planning. Also for the insurance sector, the frequent occurrence of extreme weather events and associated risks result in higher uncertainties regarding their assessments. To make insurance concepts viable, so-called climate insurances are a tool to incentivise implementation of adaptation measures by the target group, to enable appropriate risk coverage and reduce potential deductibles for consumers to an acceptable level.

1. SETTING THE SCENE

Cities are main contributors of carbon emissions, while being disproportionately vulnerable to the impacts of climate change. In urban environments, extreme weather events, such as storms, flooding or heat waves, can cause severe physical, economic and social impacts, due to large population numbers, density of buildings and infrastructure. Cities therefore have enormous potential regarding mitigation of greenhouse gas (GHG) emissions, while requiring dedicated actions concerning adaptation to the effects of a changing climate.[1]

For creation of climate resilient urban environments, municipalities need to take their role as GHG emitters, their vulnerability towards the effects of climate change, together with other transformative challenges in urban development into consideration.[2] In their development strategies, to reduce risks of climate change, actions towards both GHG **mitigation** as well as **adaptation** are required. To identify risks and develop targeted action plans, it is crucial to conduct **climate risk analyses** to enable informed decision-making and cost-benefit overviews on potential strategies.

While for many municipalities in Germany, the development of mitigation measures and strategies lately was at the forefront, climate adaptation is also becoming increasingly important on their urban development agendas. Since the 1950s, the number of days with temperatures above 30°C have gradually increased (see Figure 01). Most recently, the summer of 2018 has shown that German cities face challenges regarding long heat periods. Temperatures of almost 40°C, resulted in continuous warm nights, drying green spaces and parks, and health hazards for citizens.[3]

1.1 MITIGATION OF GREENHOUSE GAS EMISSIONS IN GERMAN CITIES

Around the world, cities account for roughly 70 % of global GHG emissions, while covering only 3 % of the global surface area.[4] Also in Germany, urban areas have an important role in achieving the country's climate goals, with the country aiming to become extensively carbon-neutral until 2050.[5] Therefore, German cities need to enhance their urban fabric in a way that minimises their

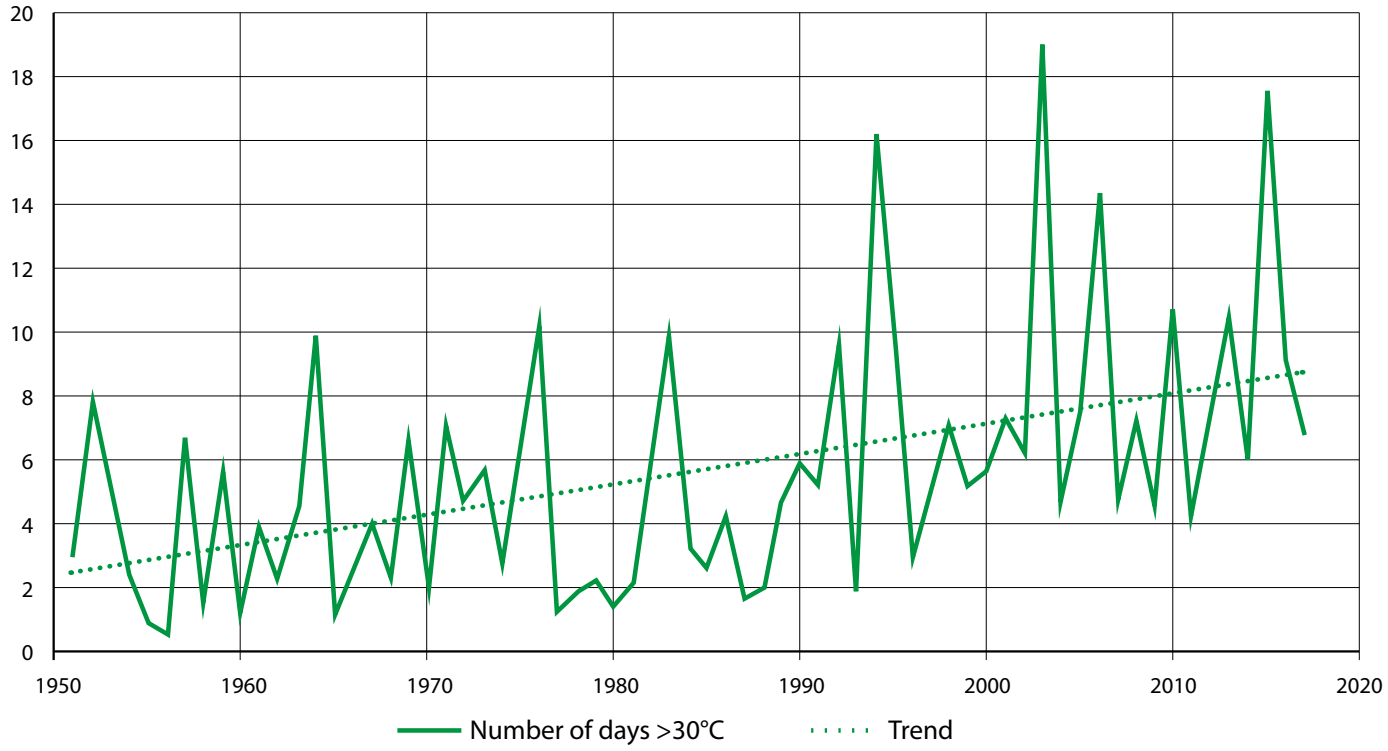


Figure 01: Number of Days above 30°C in Germany (average) (Deutscher Wetterdienst/UBA, 2018, adapted by BuroHappold)

1 EEA (2016): Urban adaptation to climate change in Europe 2016. Transforming cities in a changing climate. Luxembourg. Source: https://www.eea.europa.eu/publications/urban-adaptation-2016
2 Jolk, Anna-Kristin (2015): Gut kombiniert: Klimaschutz und Klimaanpassung in Kommunen. In: Klimaschutz & Klimaanpassung. Wie begegnen Kommunen dem Klimawandel? Köln. Source: http://edoc.difu.de/edoc.php?id=OTSJ58R4
3 Difu (2018): Die nächste Hitzewelle kommt bestimmt: Wir müssen handeln! In: Difu-Berichte 4/2018. Source: https://difu.de/node/12282?fbclid=IwAR0zXhwC-mAfkgmdabTqK_mscJx6Aw6tm-MikHV1Pig6fcHX4X8AifuOg3Q
4 BBSR (2017): CO_2-neutral in cities and neighbourhoods – the European and international perspective. Bonn. Source: https://www.bbsr.bund.de/BBSR/EN/Publications/OnlinePublications/2017/bbsr-online-10-2017-dl.pdf?__blob=publicationFile&v=3
5 BMU (2016): Climate Action Plan 2050. Principles and goals of the German government's climate policy. Berlin. Source: https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf

CO_2 output, which consumes less energy, and produces less particular matter and waste. In Germany, measures include in particular increase of **energy performance of existing and new buildings**, support of **sustainable means of urban transportation**, as well as **climate protective land use planning**.[6]

In Germany, the **building sector** accounts for around a third of the total GHG emissions, and around 40 % of the total energy consumption.[7] Minimising energy demand and emissions of buildings, therefore is an important pillar in the country's climate strategy. This includes continuous enhancement of codes for new buildings, as well as for enhancement of the existing stock.

The **mobility sector** accounts for approximately 30 % of Germany's final energy consumption, of which around 90 % is fuelled by fossil energy sources. Transportation makes up around 18 % of GHG emissions.[8] Decarbonisation of the transportation sector therefore is vital not only for reducing CO_2 emissions, but also to decrease all kinds of pollution in urban environments. Strategies include enhancement of public transportation, increase share of cycling and walking, as well as support of car sharing and forms of e-mobility.

Land use planning in urban areas combines a number of measures towards reduction of carbon emissions. For instance, apartment buildings within a dense urban environment have a significantly better energy performance than detached housesIn general, flats have significantly smaller floor areas than detached houses and a compact building design. This reduces primary energy demand, the overall ecological footprint, as well as cost for establishment of basic infrastructure. Furthermore, regarding principles of a compact city and taking advantage of short distances between different uses, also reduces the need for individual motorised modes of transportation.

1.2 ADAPTATION TO CLIMATE CHANGE IN GERMAN MUNICIPALITIES

Dense urban environments are in particular vulnerable to the effects of a changing climate. Also in Germany, sealed and built-up surfaces in cities intensify effects on overheated neighbourhoods during the summer months, and flooding due to lack of natural drainage areas and capacity in canal systems. For **adaptation** to the effects of climate change, municipalities need to develop comprehensive strategies and integrate them into their existing development planning. Furthermore, it has to be taken into account, that many German cities experience transformative change through growing resident numbers, increased demand for housing, and additional infrastructure.
In all fields of action, it is crucial to integrate the local, the regional and subnational planning level into the process. In many cases, municipalities are already embedded within regional adaptation strategies. In addition, also synergies between municipal development authorities and (municipal) infrastructure firms can support implementation of adaptation projects.[9]

In **urban development planning**, measures include, for example, regard of available construction land within existing urban structures, reducing amount of greenfield developments. To ensure natural ventilation within cities, cold air corridors should be taken into account in planning processes. In establishment of new neighbourhoods and infrastructures, potential flood areas are to be assessed to reduce damages through flooding. Other measures include the consideration of provisions for existing and new *vulnerable infrastructures*, such as hospitals, senior homes, childcare centres, or power plants. Such facilities need special attention regarding physical precaution measures and emergency plans in case of unexpected incidents.[10] Above all, harmonised planning and consideration of all authorities, the public stakeholders, and further urban actors is key, to ensure comprehensive implementation of adaptation measures.

1.3 CLIMATE RISK ASSESSMENT AND MANAGEMENT

German cities are facing different challenges and risks regarding the effects on climate change, depending on their local and regional conditions. **Vulnerability and risk analyses** are therefore important instruments to assess their specific vulnerabilities, areas of action, and define immediate priorities. Climate models, hazard and risk maps, highlighting areas prone to disasters (e.g. the Climate Plan Atlas of the City of Frankfurt), are important instruments to assess and visualise local circumstances.[11] As climate adaptation strategies and projects often entail high financial investments over long term, also climate uncertainties have to be taken into account, to prevent misallocations of resources.[12] Therefore, cities and towns are required to carry out risk assessments, and integrate it into comprehensive management frameworks, to increase their climate resilience.

On Federal level, the *German Strategy for Adaptation to Climate Change (DAS) from 2008* triggered the establishment of the *Vulnerability Network*, a research consortium comprising of several federal agencies and external scientific experts. The Vulnerability Network analysed vulnerability towards impacts of climate change

6 Deutscher Städtetag (2012): Positionspapier Anpassung an den Klimawandel. Empfehlungen und Maßnahmen der Städte. Köln. Source: http://www.staedtetag.de/imperia/md/content/dst/positionspapier_klimawandel_juni_2012.pdf
7 BMU (2016): Climate Action Plan 2050.
8 BMU (2016): Climate Action Plan 2050.
9 Weiland, Ulrike (2018): Stadt im Klimawandel. In: bpb - Dossier Stadt und Gesellschaft. Source: http://www.bpb.de/politik/innenpolitik/stadt-und-gesellschaft/216883/stadt-im-klimawandel
10 Deutscher Städtetag (2012): Positionspapier Anpassung an den Klimawandel. Empfehlungen und Maßnahmen der Städte.
11 Weiland, Ulrike (2018): Stadt im Klimawandel.
12 Brasseur, Guy (Ed.) et al. (2017): Klimawandel in Deutschland. Entwicklung, Folgen, Risiken und Perspektiven. Springer, Berlin. Source: http://oceanrep.geomar.de/34663/1/bok_978-3-662-50397-3.pdf

in different regions and sectors throughout Germany. It provides a valuable baseline for municipalities to develop their individual risk assessments.[13] The Network utilises the vulnerability concept of the *Intergovernmental Panel on Climate Change (IPCC)*. IPCC defines vulnerability as a *"degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes" and a "function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity".*[14] Focus of the Network's assessment was on potential impacts of climate change, regarding present, and scenarios on near future from 2021 to 2050 and distant future from 2071 to 2100. Furthermore, it analysed the adaptation potential of citizens in Germany and governance structures to implement adaptation measures.[15]
In general, **climate risk assessments** are carried out to estimate vulnerability towards impacts of climate change, and identify potential hazards. Existing climate-related data and projections are analysed, also integrating environmental aspects, and socio-economic challenges. Vulnerabilities, and their risks are identified and scrutinised. Subsequently, options for adaptation measures as well as their cost and potential benefits are assessed, and eventually agreed upon. To streamline the process, it is important that agreements are made under consideration of a broad variety of stakeholders, regarding predefined decision making criteria, and a common ground on which targets should be met. In

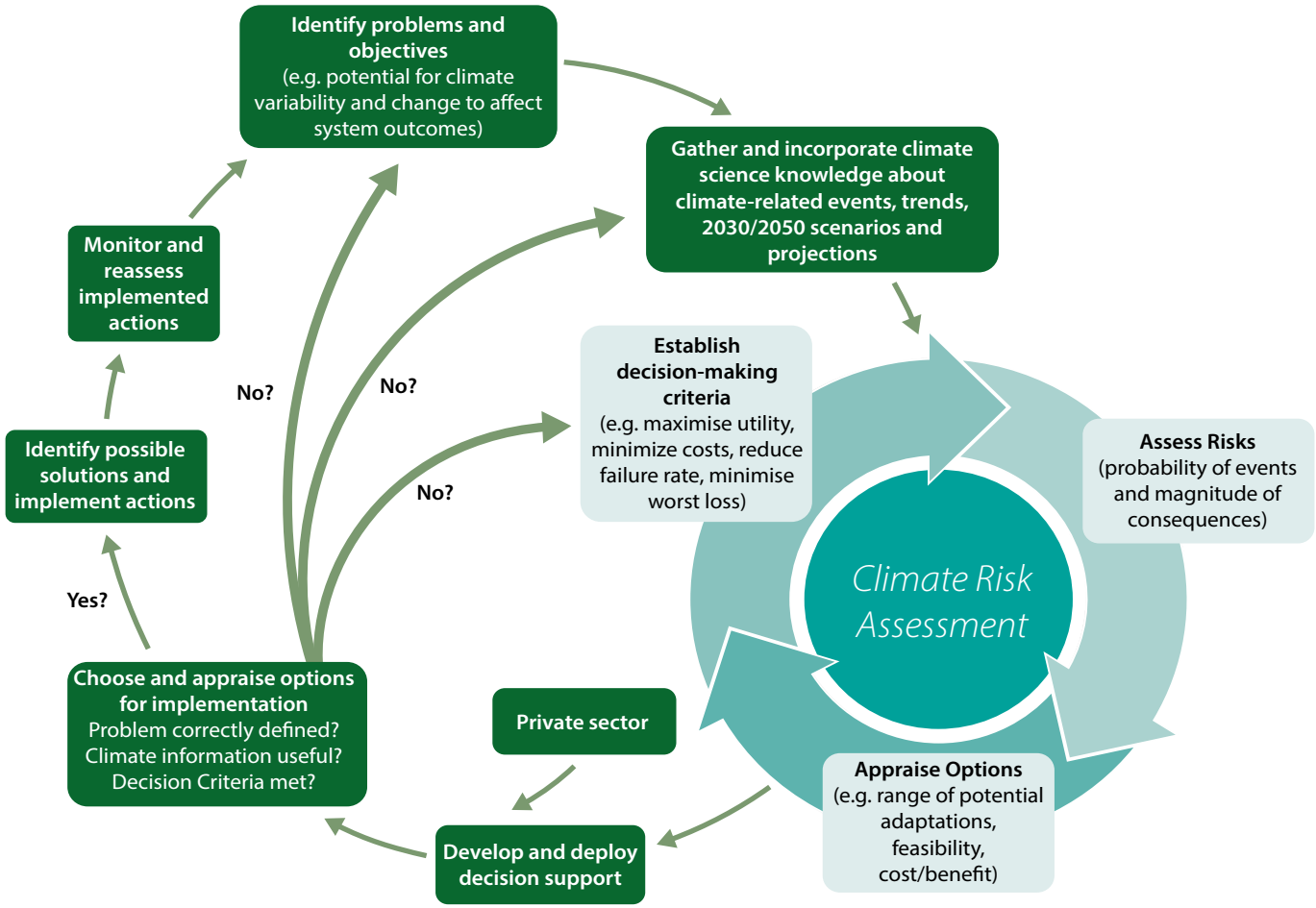


Figure 02: Pillars of a Plus Energy House (based on Fraunhofer Institute for Building Physics; BMWi, 2016, adapted by BuroHappold)

13 adelphi / PRC / EURAC (2015): Vulnerabilität Deutschlands gegenüber dem Klimawandel. Umweltbundesamt. Climate Change 24/2015, Dessau-Roßlau. Source: https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/climate_change_24_2015_vulnerabilitaet_deutschlands_gegenueber_dem_klimawandel_1.pdf
14 Parry, M.L. et al. (2007): Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers. Source: http://www.un-documents.net/ipcc-ar4/wg2-spm.pdf
15 adelphi / PRC / EURAC (2015): Vulnerabilität Deutschlands gegenüber dem Klimawandel.

carefully designed risk assessments, a decision-making support system further feeds in additional inputs, and monitors the whole process (see Figure 02).[16]

The full spectrum to prepare for disasters and steer related operations is called *Disaster Risk Management* (DRM). While it often starts with assessment of climate related risks, DRM also includes implementation of prevention measures, appropriate preparation and response during, and after emergencies. Furthermore, comprehensive DRM planning involves stakeholders on several levels and affected target groups.

The *Advancing Climate Risk Insurance Plus (ACRIplus)* programme, implemented by GIZ and the *Munich Climate Insurance Initiative (MCII),* shaped a DRM approach, interlinking different phases, before, during, and after a climate-related disaster hit. The concept, as described below, has a particular regard on risk transfer mechanisms, including climate insurances, to prevent potential adverse economic impacts of disasters.

Figure 03: Disaster Risk Management Cycle (GIZ / MCII, 2017)

1.3.1 Integrated Climate Risk Management (ICRM)

The ICRM cycle, based on existing international DRM frameworks, regards several phases to manage climate risks and impacts. It comprises of five phases, starting with the Prevention phase:

1. **Prevention** - encompassing a risk assessment, analysing vulnerability, exposure, and hazards regarding regions, sectors and target groups. Furthermore, it includes the development of project options to prevent climate change related disasters.

2. **Retention & Transfer** - including cost-benefit calculations, to decide upon implementation of specific options regarding pre-disaster measures and / or climate insurances, as well as outlook on financial consequences of impacts.

3. **Preparedness** - targeting on set up of appropriate response structures and mechanisms in case of a disaster. This includes training and establishment of dedicated alert and emergency procedures, plans and units.

4. **Response** - including immediate emergency measures after a disaster has occurred, and securing appropriate finance. Response mechanisms are highly dependent on investments taken in the previous phase.

   Recovery - comprising of implementation of reconstruction and recovery schemes. It considers the "build back better" approach, to integrate weaknesses and vulnerabilities of the established disaster prevention systems in the reconstruction process. [17]

16 Travis, W., Bates, B. (2014): What is climate risk management? In: Climate Risk Management 1. 1-4. Source: https://www.sciencedirect.com/journal/climate-risk-management/vol/1

17 MCII / GIZ (2017): Increasing Resilience through Integrated Climate Risk Management. Source: http://www.climate-insurance.org/fileadmin/mcii/pdf/ACRI_/ACRI__ICRM_Factsheet_final.pdf

2. REGULATORY FRAMEWORKS

With effects of climate change stretching out far over administrative borders, local climate action is embedded within multiple tiers of governance. Municipal climate policy is shaped by frameworks and strategies of the *United Nations (UN),* the *European Union (EU),* as well as German Federal and subnational administration. In addition, organisations such as the *Association of German Cities*, also influence municipal climate policy.[1]

In the past decade, Germany's Federal Government adopted several strategies and frameworks, aiming to integrate climate adaptation measures into a number of sectors and related legislation. The DAS*,* as well as the subsequent *Adaptation Action Plans (APA),* aim to provide orientation for municipal governments regarding their adaptation strategies.

2.1 GERMANY'S CLIMATE ADAPTATION STRATEGY AND ACTION PLAN

In 2008, the Federal Government of Germany passed the DAS, building the main, medium-term framework for adaptation to the effects of a changing climate within the country and beyond. The strategy includes outlooks and projections on the effects of a changing climate, and describes potential threats and defines sectors for action, such as the building sector and regional and spatial planning. DAS outlines a systematic process for risk assessment, aiming to reduce vulnerability of the identified focal areas. In addition, it guides the scope of collaboration between with subnational governments and other public stakeholders.[2]

The subsequent *APA I* of 2011 further specifies Germany's efforts in climate adaptation and highlights objectives and activities. The action plan outlines dedicated activities the Federal Government implements together with Germany's subnational governments. This includes climate impact assessment and monitoring systems, development of cooperation networks, and joint-concepts and targeted measures, as well as the establishment of subsidy programmes. APA I builds upon four strategic pillars:

- provision of knowledge, information and to enable networking between stakeholders,
- support by the Federal Government in establishing guiding frameworks and financial assistance,
- integration of adaptation measures in government-owned infrastructure and infrastructure projects,
- consideration of Germany's responsibilities regarding climate adaptation in international development cooperation.[3]

Every four years, the Federal Government publishes a progress report on implementation of DAS, and updates the scope of work regarding climate adaptation in Germany. The 2015 progress report includes the updated *APA II,* also defining concrete timeframes and finance plans. Furthermore, six main fields of climate action are highlighted:

- **water**, targeting water resource management, protection of coastal zones, marine life as well as fishery,
- **land**, with a focus on soil management, agriculture, management of forests and biodiversity,
- **infrastructures**, including the building sector, energy supply, transportation and mobility,
- **industry**, comprising tourism, finance sector, business and industrial production,
- **heath**, regarding human wellbeing,
- **regional planning and civil protection**, intending to include adaptation measures through cross-sectoral spatial, regional and urban development planning, as well as actions for civil protection in case of extreme weather events. [4]

To identify risks and potential hazards related to climate change in Germany, the Federal Government established the above mentioned *Vulnerability Network*, a research consortium comprising of several federal agencies and scientific experts. Outlooks on climate projections and specific regional vulnerabilities are established through the network.

The 2015 progress report of the Vulnerability Network identified main challenges for Germany, requiring dedicated preventive actions and strategies. Identified challenges include (i) heat stress in urban agglomerations, (ii) water management, including water scarcity during heat waves, (iii) heavy rainfall and flooding, (iv) river flooding, (v) damage on coastal areas, (vi) impacts on biodiversity and natural development.[5] Nearly all of the identified issues are highly relevant for the urban context, and can be targeted through measures regarding physical development planning and adaptation of the built environment.

1 Deutscher Städtetag (2012): Positionspapier Anpassung an den Klimawandel.
2 BMU (2008): German Strategy for Adaptation to Climate Change. Source: https://www.bmu.de/fileadmin/bmu-import/files/english/pdf/application/pdf/das_gesamt_en_bf.pdf
3 BMU (2011): Adaptation Action Plan I; Source: https://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/aktionsplan_anpassung_klimawandel_en_bf.pdf
4 BMU (2016): Adaptation to Climate Change. Initial Progress Report by the Federal Government on Germany's Adaptation Strategy. Berlin. Source: https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/fortschrittsbericht_anpassung_klimawandel_en_bf.pdf
5 BMU (2016): Adaptation to Climate Change.

2.2 CLIMATE ADAPTATION STRATEGIES AND DEVELOPMENT PLANS OF GERMAN CITIES AND TOWNS

As a result of the establishment of Germany's DAS and APA, many German cities developed their specific climate adaptation measures. Until 2017, around 90 % of all German municipalities with more than 100,000 inhabitants have developed either full adaptation strategies or integrated activities with a climate-related focus in their development plans.[6]

After establishment of urban adaptation concepts, strategies and plans, the main challenge for municipalities remains the actual implementation of planned measures. Large stakeholder networks, different focal points, means of understanding and interests, in many cases, can hamper realisation. Short-term economic interests of individual actors, high upfront cost, and long financial payback periods can hold up even ambitious adaptation concepts. Hence, high transparency in development of action plans, including information and participation of the affected public, can reduce potential barriers.

Here, despite ambitious strategies on Federal, subnational and municipal level, the most important sphere remains the district or neighbourhood level. Through transparent process development, information and participation, local commitment of residents and businesses directly affected by climate impacts and planning measures is can be increased. At the same time, at neighbourhood or district level, the sometimes abstract and conceptual design of adaptation strategies is broken down to concrete and tangible measures.[7]

2.3 GERMAN URBAN PLANNING INSTRUMENTS FOR INCREASED CLIMATE RESILIENCE

Climate change affects various urban sectors at once and is considered a *systemic challenge*.[8] While German cities are required to react towards other trends of transformation, such as demographic changes, population increase, housing supply and improvement of infrastructure, they also need to consider climate change related planning at the same time. With many urban sectors, such as the construction industry, transportation, urban mobility, industrial production and commercial developments are contributing GHG emissions, they are also increasingly being affected by the impacts of a changing climate.[9] Therefore, means for climate mitigation and adaptation have been integrated in to Germany's legislative framework regarding building codes, land-use planning, and urban renewal.

The most important regulation guiding municipalities physical development planning is the *German Building Code (BauGB)*. BauGB comprises of statutory German planning and zoning laws, regulations on development plans, and outlines environmental impact assessment. [10] **Since its 2011 update, municipalities are required to consider integrated adaptation strategies for land use planning and infrastructure development.** In addition, aspects of climate adaptation in urban redevelopment and regeneration are considered. By that, adverse climate impacts are now also considered in BauGB as a legitimate reason for redevelopment activity.[11]

In addition, the German framework for Federal subsidies on urban renewal, the *Administrative Agreement on Urban Development (Verwaltungsvereinbarung Städtebau)*, emphasises on measures regarding climate mitigation and adaptation as well. Climate mitigation and adaptation is considered as an interdisciplinary issue, to be considered throughout all Federal subsidy programmes on urban rehabilitation.[12]

6 Christian Kind and Katharina Sartison (2017): Wie deutsche Städte sich an den Klimawandel anpassen. Source: https://www.umweltbundesamt.de/themen/wie-deutsche-grossstaedte-sich-an-den-klimawandel
7 IC Ruhr (2014): InnovationCity. Leitfaden Klimagerechter Stadtumbau. Bottrop.
8 EEA (2016): Urban adaptation to climate change in Europe 2016.
9 BBSR (2016): Klimaresilienter Stadtumbau. Bilanz und Transfer von StadtKlimaExWoSt. Bonn.
10 Baugesetzbuch (BauGB) §§ 1 – 10a. Source: https://www.gesetze-im-internet.de/bbaug/BJNR003410960.html
11 BBSR (2016): Klimaresilienter Stadtumbau. Bilanz und Transfer von StadtKlimaExWoSt. Bonn.
12 VV Städtebauförderung 2018.

3. FINANCIAL INCENTIVES AND SUBSIDIES

Germany's Federal Government offers a number of subsidy programmes to react to challenges faced through the changing climate. The programmes targeting adaptation measures are based on the framework of DAS. Financial assistance is provided both for short-term projects, as well as for long-term concepts, including regional and urban development plans.[1]

3.1 FEDERAL PROGRAMME FOR ADAPTATION TO CLIMATE CHANGE

The *Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU*) in 2012 introduced the *Programme for Adaptation to Climate Change*, funding measures specifically targeting adaptation to the effects of climate change. Financial assistance is issued to municipalities, businesses, educational facilities, associations or similar institutions based in Germany for them to establish adaptation concepts, educational programmes, or flagship projects.

For instance, the programme supported integrated climate adaptation strategies in several cities and regions (e.g. regions of Bremen-Oldenburg, Kiel, etc.), research on instruments and planning tools for climate adaptation (e.g. rainfall or flood hazard maps), or educational programmes (e.g. adaptation measures in the tourist sector, agricultural sector, or health sector). Eligible projects are selected in a two-step process, and supported with grants between 100,000 and 300,000 Euro.[2]

3.2 MAKING CLIMATE CHANGE SUSTAINABLE IN REGIONS – KLIMZUG PROGRAMME

The *Making Climate Change Sustainable in Regions Programme (KLIMZUG)* provided financial assistance for climate adaptation projects between 2008 and 2014, initiated by the Federal Ministry of Education and Research. KLIMZUG targeted the development of strategies regarding climate adaptation and associated weather extremes in seven model regions. Adaptation strategies were then integrated into existing regional and urban planning frameworks.

The seven model regions of KLIMZUG covered different topographic and climatic requirements. This included coastlines as well as mountain regions, or landlocked urban agglomerations. For instance, adaptation strategies were developed and implemented for the model region around the city of Hamburg in Northern Germany, the German Baltic Sea coast, the Berlin-Brandenburg region, or the region around Dresden located by the Elbe River (see below). Furthermore, KLIMZUG encouraged formation of regional support networks for long-term cooperation, modes of capacity building and increasing sensitivity regarding climate change. By KLIMZUG's model approach, strategies and projects are showcased, with the intention to upscaling them towards other regions in Germany and beyond.[3]

3.3 NATIONAL CLIMATE INITIATIVE

The *National Climate Initiative (NKI)* of BMU is a support programme targeting implementation of measures for GHG or climate change adaptation. Since 2008, NKI provides financial assistance for a variety of public / municipal and private stakeholders throughout Germany, with changing thematic focus. Current schemes of NKI include financial support for municipal mitigation / adaptation projects through the *Local Authorities Guideline (Kommunalrichtlinie)* framework, the implementation of bicycle infrastructure, establishment of municipal model projects for GHG mitigation, or development of small cogeneration plants.

Regarding climate action in municipalities, especially finance through NKI's Local Authorities Guideline is highly relevant. The scheme supports initial counselling for municipalities and municipal companies regarding climate mitigation and adaptation, development of climate action plans, as well as implementation management.[4] Since implementation, NKI financially assisted more than 25,000 projects with a sum of around 790 million Euro. Through support of NKI, cumulative investments of 2.5 billion Euro were taken on projects related to climate action. By that, more than 600,000 tons of CO_2 equivalents were mitigated.[5]

3.4 INTERNATIONAL CLIMATE INITIATIVE

The *International Climate Initiative (IKI)* is another programme of BMU specifically targeting projects located in developing and emerging economies. Since 2008, the IKI provides financial support for projects targeting (i) mitigation of GHG emissions, (ii) adaptation to effects of climate change, (iii) conservation of natural carbon sinks, and (iv) conservation of biodiversity. Institutions eligible to receive IKI funding are German Federal implementing agencies (e.g. GIZ), international and non-governmental organisations, businesses, development banks, or research facilities.[6]

1 BMU (2016): Adaptation to Climate Change.
2 Projektträger Jülich (2018): Förderung von Maßnahmen zur Anpassung an die Folgen des Klimawandels. Source: https://www.ptj.de/folgen-klimawandel
3 UBA (2016): KLIMZUG – Klimawandel in Regionen zukunftsfähig Gestalten. Source: https://www.umweltbundesamt.de/themen/klima-energie/klimafolgen-anpassung/werkzeuge-der-anpassung/projektkatalog/klimzug-klimawandel-in-regionen-zukunftsfaehig
4 BMU (2018): Nationale Klimaschutzinitative. Förderprogramm Kommunalrichtlinie. Source: https://www.klimaschutz.de/kommunalrichtlinie
5 BMU (2018) Nationale Klimaschutzinitiative. Zahlen und Fakten. Source: https://www.klimaschutz.de/zahlen-und-fakten
6 BMU (2018) Internationale Klimaschutzinitiative. Förderinstrument IKI. Source: https://www.international-climate-initiative.com/en/about-the-iki/iki-funding-instrument/

By the end of 2017, the IKI has initiated more than 600 projects, and financially supported with around 2.7 billion Euro. More than half of the issued funds target mitigation projects, with further 20 % aiming for measures regarding climate adaptation.[7] Supported projects by IKI include the *Sino-German Urbanisation Partnership*, or the *ACRIplus* programme.

3.5 FUNDING OF INNOVATION AND RESEARCH ON CLIMATE CHANGE

Apart from subsidy schemes targeting development and implementation of concrete strategies and projects, others focus on research and development, as well as design of new, innovative measures on climate mitigation and adaptation.

For instance, the *Federal Government's Experimental Housing and Urban Development Programme (ExWoSt)* supports research, development of flagship projects and prototypes. Regarding climate adaptation, the scheme currently includes dedicated research focusing on climate resilient urban redevelopment with Federal funding through the Urban Reconstruction Programmes. Modes of planning, cooperation and communication in rehabilitation processes in dense urban areas are scrutinised. Here, research includes development of case studies, including cities of Berlin or Dortmund, amongst others.[8]

Another programme initiated by the *European Institute of Innovation & Technology (EIT),* is *Climate-KIC*, an EU-wide research network aiming for a zero-carbon future and increased climate resilience. The EIT Climate-KIC interlinks public and private stakeholders from research, industry and business. It supports innovative ideas and start-ups, and provides educational and training programmes. The programme has four thematic focal areas, (i) urban transition, (ii) sustainable production systems, (iii) sustainable land use, and (iv) decision metrics & finance.[9] Since its initiation in 2010, start-ups supported by Climate-KIC were able to attract more than half a billion of investments.[10]

7 BMU (2018): 10 Years IKI – Facts and Figures. IKI funding volume by funding area 2008 – 2017. Bonn. Source: https://www.international-climate-initiative.com/fileadmin/Dokumente/2018/10IKI_Facts_Figures_NEU.pdf
8 BBSR (2018): ExWoSt Forschungsfelder – Klimaresilienter Stadtumbau. Source: https://www.bbsr.bund.de/BBSR/DE/FP/ExWoSt/Forschungsfelder/2017/klimaresilienter-stadtumbau/01-start.html?nn=430172
9 European Institute of Innovation & Technology (2018): EIT Climate-KIC. Source: https://eit.europa.eu/eit-community/eit-climate-kic
10 Climate-KIC (2018): Climate-KIC. Source: http://climate-kic.de/%C3%BCber

4. BEST PRACTICE CASE STUDY

4.1 GREEN MOABIT – DEVELOPMENT PLAN FOR A SMART AND SUSTAINABLE DISTRICT IN BERLIN

Figure 04: Project Plan of Green Moabit © Benjamin Janecke (Source: https://de.wikipedia.org/wiki/Datei:BerlinHauptbahnhof.jpg)

Green Moabit is an urban development plan for Berlin's district of Moabit West. Various forms of industry characterise the district. More than half of the district's area is predominately industrial, with the other parts being residential neighbourhoods. Projected population growth for Moabit is at least 24,000 new residents by 2030, generating additional demand for housing. Therefore, the district aims to increase the existing residential stock, and avoid effects of gentrification. Furthermore, it aims to become climate neutral until 2050, alongside the Federal Government's climate goals, implementing measures of energy efficiency across all sectors. The existing industrial facilities, still in use, pose a significant challenge regarding the climate goals for 2050. Throughout its development plan, Moabit West integrates mitigation and adaptation measures.[1]

Between 2011 and 2015, the urban development plan of "Green Moabit" was developed under consultation of urban planners, public administration, communication experts and additional specialists focusing on energy, water, transportation, and circular economy. In establishment of Green Moabit, several opportunities were assessed regarding environmental protection, GHG mitigation and adaptation to climate change, particularly targeting areas shaped by industry. The analysis also included existing buildings and infrastructure, as part of the development strategy. The expert group defined specific sustainability strategies, focusing on water, waste, energy, mobility, public and private spaces, social infrastructure and environmental management. [2]

The resulting action plan of Green Moabit comprises of several concrete implementation projects. The measures include increase of energy-efficiency in commercial buildings, implementation of rainwater harvesting and utilisation for cooling and irrigation purposes, enhancing transportation systems and reducing CO_2 emissions (e.g. public transportation, e-mobility, multi-modal hubs), heat through cogeneration plants, solar energy plants, and implementation of heat recovery systems. Creation of new green spaces and rehabilitation of existing ones, is another main pillar of Green Moabit. By planting of trees, expanding green areas, and naturally harvesting rainwater, surfaces for rainwater drainage are created. The implementation of the individual projects is ongoing until 2024.[3]

Implementation of Green Moabit was accompanied of research initatives, such as the EIT Climate-KIC innovation programme, aiming for *Smart Sustainable Districts* (SSD). Through dedicated funding and establishment of research networks, SSD developed planning tools, and analysed the potential of e-mobility and low-emission transport technology, energy and thermal performance of buildings in the area. As a pilot district within Berlin, Green Moabit is showcasing models for other parts of the city.[4]

1 EIT Climate-KIC (2018): Moabit West, Berlin. Source: https://www.climate-kic.org/success-stories/moabit-west-berlin
2 Senatsverwaltung für Stadtentwicklung und Wohnen Berlin (2018): Stadtteilentwicklungskonzept Green Moabit. Source: https://www.stadtentwicklung.berlin.de/staedtebau/foerderprogramme/stadtumbau/D6-Green-Moabit.6368.0.html
3 Senatsverwaltung für Stadtentwicklung und Wohnen Berlin (2013): Stadtteilentwicklungskonzept GREEN MOABIT – Bericht. Source: https://www.stadtentwicklung.berlin.de/staedtebau/foerderprogramme/stadtumbau/fileadmin/user_upload/Dokumentation/Projektdokumentation/Mitte/FG_Moabit_Nordring_Heidestr/D6_Green_Moabit/PDF/Green_Moabit_Bericht.pdf
4 EIT Climate-KIC (2018): Moabit West, Berlin.

CASE STUDY

4.2 EUROPEAN GREEN CAPITAL OF 2017: ESSEN, RUHRGEBIET

Figure 05: European Green Capital of 2017: Essen, Ruhrgebiet © Wiki05

In 2017, Essen was awarded the European Green Capital, considered a role model of structural change towards climate residence and sustainable urban development. Essen was chosen for its exemplary practices in enhancing the environment and biodiversity and its efforts to reduce water consumption. In addition, Essen has been for many years involved in numerous networks and initiatives to improve the region's resilience in the face of climate change, to achieve sustained climate mitigation and reduce CO_2 emissions.[1]

Located in the Ruhrgebiet area, the city underwent major transformations in the past 150 years. Since the early 19th century, Essen was characterised by massive coal production and heavy industry, negatively affecting the region's environment. After decline of the coal and steel industries in the second half of the 20th century, Essen gradually developed into a city oriented towards a service- and finance economy. Essen aims to include a two-legged approach of mitigation and adaptation into its urban development strategy, transitioning into a climate-resilient city. Essen targets to reduce its GHG emissions by 40 % before 2020, compared to 1990 levels. The city has committed itself to reduce its emissions by 10 % every 5 years. By that, the city's aims go beyond the EU, Federal and subnational targets.[2]

Part of the city's mitigation and adaptation strategy is a working group, organising implementation of an action plan and dedicated measures. The action plan consist of 160 individual projects, which have been progressively implemented. Some of the planned mitigation projects include measures to enhance energy efficiency. For example, public lighting has been modernised through energy-efficient LEDs and sodium lamps. Furthermore, efforts are taken to implement the Passive House standard in new municipal buildings, and increase the renovation rate of existing buildings up to 3 %. A city's own agency, *klima/werk/stadt/essen*, offers free of charge counselling services for building owners on energy efficiency measures for refurbishments and new constructions. Essen also participates in a regional programme, ALTBAUNEU, offering information on enhancement of building energy performance, including a database of local experts, and advice on various Federal and state subsidy schemes. Other measures include the establishment of more than 1,400 photovoltaic systems, and a biomass heating plant, contributing to decentralised energy generation. To transform the mobility sector, improvements in the transportation infrastructure have been implemented for cyclists, pedestrians and public transport. Furthermore, the city offers service programmes for citizens, to gain knowledge on energy efficient behaviour, especially targeting low-income households. Through the programme called *EnergySavingService (EnergieSparService)*, households are able to save up to 140 € of energy cost per year, reducing their CO_2 output by 300 kg.[3]

1 European Green Leaf (2016): 2017 EGCA Shortlist. Source: http://ec.europa.eu/environment/europeangreencapital/applying-for-the-award/2017-egca-applicant-cities/index.html
2 City of Essen (2017): Essen 2017. Application for European Green Capital. Climate change: mitigation and adaptation. Source: http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2015/06/01_Application-EGC-2017_Climate-Change_ESSEN.pdf
3 Klimawerkstadt Essen (2018): Persönliche Energiewende vor Ort. Source: http://www.klimawerkstadtessen.de/klimawerkstadtessen_wohnenleben/klimawerkstadtessen_energiesparservice_essen/energiesparservice_essen.de.jsp

Essen participates in a regional programme, the so-called *100 climate friendly neighbourhoods (100 Klimaschutzsiedlungen)* initiative, realising housing estates following dedicated planning guidelines, reducing GHG emissions in the respective neighbourhoods by 50 – 60 % below reference buildings complying to Germany's *Energy Saving Ordinance* of 2009, EnEV 2009. Currently, three neighbourhoods are classified as *climate friendly neighbourhoods*. For example, a development called *Essen West*, includes residential buildings following principle of solar construction, with optimised orientation, established as a conversion project on a former inner city brownfield. The concept foresees the reduction of individual motorised transportation, with the whole neighbourhood being only accessible by foot. Realisation of a cogeneration unit optimises decentralised energy generation through renewables.[4]To react towards the effects of climate change, Essen developed an adaptation strategy, after carrying out a public participation process, and analysing local risks and vulnerabilities. As a main pillar of the strategy, the city aims that more than half of the city's surface area remain green and with open spaces, or waterbodies. The amount of green infrastructure within the city is further enhanced through green rooftops, façades, inner courtyards and streetscapes, functioning as natural drainage areas. In addition, the city integrates conscious design of waterbodies into its development strategies, and opening up cooling channels to ventilate dense inner city districts, avoiding heat islands. In Essen's urban development concept, climate adaptation is considered a topic relevant across all planning sectors, and part of a two-legged approach interlinked with mitigation measures.[5]

Sectoral master plans include improvement and transformation of former industrial sites to open and green spaces, also including areas forming part of the transition of *Emscher Landscape Park*, a former industrial hub turning into a network of green areas and parks, initiated through the *International Architecture Exhibition (IBA)* between 1989 and 1999 (see also *Keystone Paper #3: Transformative City*). Another plan focuses on waterbodies, remodelling open water areas within the city. The overall goal of Essen's "green" strategy is to enable residents to visit green spaces of an interlinked network within a range of maximum 500 m. Main leisure areas include the Ruhr and Emscher Valley, Zollverein or Gruga Park, exemplifying the city's ambition towards revitalising and redeveloping formerly polluted brownfields. By that, green multi-use facilities are created, combining ambitions of climate protection with leisure facilities.[6]

4 Klimawerkstadt Essen (2018): Klimaschutzsiedlungen. Energetisch optimierte Planungsansätze in Essen. Source: http://www.klimawerkstadtessen.de/klimawerkstadtessen_startseite_1/klimawerkstadtessen_klimaprojekte/klimaschutzsiedlungen/klimaschutzsiedlungen.de.jsp

5 City of Essen (2017): Essen 2017. Application for European Green Capital. Climate change: mitigation and adaptation.

6 City of Essen (2017): Essen 2017. Municipal Green Areas that incorporate Sustainable Land Use. Source: http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2015/06/03_Application-EGC-2017_Green-Areas_ESSEN.pdf

CASE STUDY

4.3 REGIONAL INTEGRATED CLIMATE ADAPTATION PROGRAMME FOR THE DRESDEN REGION - REGKLAM

Figure 06: Dresden, with overflow areas next to river Elbe © dronepicr (Source: https://www.flickr.com/photos/132646954@N02/25248438946)

The regional integrated climate adaptation programme for the model region of Dresden, REGKLAM, was carried out as a model programme funded by KLIMZUG, from 2008 until 2013. REGKLAM consists of a comprehensive strategy on local and regional climate adaptation around Dresden, also including concrete goals and measures. Furthermore, the actions included in REGKLAM build directly upon the framework of DAS and APA.[1]

For the city of Dresden situated next to the Elbe river, a rise in outdoor temperatures between 1.4 to 3.5°C is expected until end of the 21st century, resulting in hot, and dry summers, and warmer winter months. Between 1991 and 2010, the average annual temperature has risen by +0.6°C, compared to the reference period from 1961 to 1990.[2] According to projections, the occurrence of heat waves in summer is likely to increase. The number of days with temperatures above 30°C has risen by 3.4 days between 1991 and 2010 on average compared to the reference period, and are projected to grow further by 3.9 days between 2021 and 2050, and by 13.5 days until the end of the century.Dense inner city neighbourhoods lacking green spaces are affected the most, being at risk of urban heat islands and continuous warm temperatures during day- and nighttime.[3] At the same time, heavy and intense rainfalls as well as flooding are expected to happen more frequently. Between 1991 and 2010, the average annual rainfall increased by +45 mm compared to the reference period.[4]
To address those threats, concrete measures for implementation were developed in REGKLAM, key projects prepared, and regional stakeholder networks activated. REGKLAM focussed on the following strategic pillars:

- Buildings and urban structures, including measures for adaptation of settlements, rehabilitation of existing neighbourhoods, reuse of brownfields in inner city areas, under consideration of high quality green and open spaces.
- Water supply and management, covering ecosystems in and around Dresden, sustainable use of water resources, and research on technical systems of water supply and wastewater treatment.
- Agriculture and forestry, including strategies for the preservation of biological resources, supply of recreational areas acknowledging climate risk management as an important regional economical factor.
- Nature conservation, highlighting the preservation of vital ecosystems and biodiversity, including measures for a climate resilient landscape. [5]

REGKLAM shows, how a consistent, long-term strategy for climate adaptation for a city and its surrounding region is developed and implemented. Findings of the individual focal areas were combined to an Integrated Regional Climate Adaptation Strategy for the whole Dresden region. The programme answered fundamental questions of foreseeable developments through a changing climate, and discussed their social, and economic adaptation requirements, as well as potentials that lie in adaptation measures.

1 REGKLAM-KONSORTIUM (ed.) (2013): Risiken beherrschen, Chancen nutzen. Die Region Dresden stellt sich dem Klimawandel. Strategiekonzept zum Integrierten Regionalen Klimaanpassungsprogramm für die Region Dresden. Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/Strategiekonzept_130924_final_online.pdf
2 REGKLAM-KONSORTIUM (ed.) (2013): Integriertes Regionales Klimaanpassungsprogramm für die Region Dresden. Grundlagen, Ziele und Maßnahmen. Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/Grundlagen_Ziele_Ma%C3%9Fnahmen_v2.0_final_online.pdf
3 TU Dresden (2013): Faktenblatt Klimawandel Dresden. Signale für die Klimaentwicklung von Dresden. Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/130122_Faktenblatt_Klimawandel-Dresden.pdf
4 TU Dresden (2013): Faktenblatt Regionaler Klimawandel. Regionale Klimaszenarios für die Modellregion Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/130122_Faktenblatt_regionaler-Klimawandel.pdf
5 Müller, Bernhard (ed.) (2013): Risiken beherrschen, Chancen nutzen. Die Region Dresden stellt sich dem Klimawandel.

5. EMERGING TRENDS

5.1 SPONGE CITIES – ADAPTATION TO CLIMATE CHANGE THROUGH GREEN SPACES AND RETENTION AREAS

Especially for cities experiencing flooding through heavy persistent rainfalls, as well as long drought periods in the summer months, the so-called concept of a *sponge city* is a highly relevant strategy for climate adaptation. Based on the principle of decentralised rainwater harvesting, it supports the natural water balance through integrating the consideration of precipitation, evaporation, increase and reduction of water levels in development planning.[1]

Municipalities utilising the principle take the benefit of storm water into account through providing natural drainage areas. Sufficient green surfaces absorbing water, water channels, and emergency drainage planes, mitigate the risk of flooding. In addition, they relieve the municipality's sewage network, with excess water being directly routed back to the natural water cycle. Concerning heatwaves and resulting droughts, the established green spaces generate natural water storages, and provide cooling through unsealed surfaces and increased vegetation.

Additional measures of rainwater harvesting include appropriate storage facilities, improvement of soil conservation, and continuous water supply mechanisms for vegetation. This also contributes positively on the microclimate. Therefore, while providing drainage areas and reducing flood risk, the concept has a positive impact on climatic conditions of urban environments, avoiding urban heat islands, and enhancing cooling effects. In addition, it increases functionality of parks, which are ideally integrated into a holistic planning approach, forming green networks throughout a city, and by that equally improving accessibility of green and open spaces for local residents.[2]

5.2 CLIMATE INSURANCES IN THE CONTEXT OF ADAPTATION STRATEGIES

In the spectrum of adaptation measures, insurances targeting impacts of climate change related disasters form an increasingly important instrument. While reducing economic losses for public and private entities, they incentivise individual adaptation measures of the target group.

For the insurance sector, more frequent occurrence of extreme weather events, and associated risks, result in higher uncertainties in their assessments, challenging insurability. To make insurance concepts viable, thus enabling appropriate risk coverage and reducing potential deductibles for consumers to an acceptable level, the target group is urged to increase their efforts to adapt to climate change. To reduce individual risks, for instance, insurance companies can provide discounts on premiums in case of establishment of high quality building structures, or endorse consideration of regional flood-maps during urban expansion or renewal processes.[3]

Also in the context of international development, climate insurances are gaining momentum for increased climate resilience amongst vulnerable groups in developing and emerging economies. For example, the Federal Government of Germany is supporting the *InsuResilience Global Partnership*, aiming to enable access to climate insurances for 400 million poor and endangered people.[4] Also the above-mentioned ACRIplus programme, implemented by GIZ and MCII, aims to shape tailored forms of insurance together with local stakeholders, and to incentivise adaptation on climate change, to reduce individual risk, hence reducing premiums and financial burdens.[5]

1 Sieker (2018): Das Konzept der Schwammstadt (sponge-city). Source: https://www.sieker.de/de/fachinformationen/umgang-mit-regenwasser/article/das-konzept-der-schwammstadt-sponge-city-577.html
2 UBA (2017): Dauerregen in Deutschland: Wie können wir vorsorgen? Source: https://www.umweltbundesamt.de/themen/dauerregen-in-deutschland-wie-koennen-wir-vorsorgen
3 UBA (2011): Versicherungen. In: THEMENBLATT: Anpassung an den Klimawandel, Dessau-Roßlau. Source: https://www.umweltbundesamt.de/sites/default/files/medien/364/publikationen/kompass_themenblatt_versicherung_2015_net.pdf
4 BMZ (2017): InsuResilience. Klimarisikoversicherungen für arme und verwundbare Menschen in Entwicklungsländern. Berlin / Bonn. Source: http://www.bmz.de/de/zentrales_downloadarchiv/klima_und_cop23/BMZ_Infoblatt_InsuResilience.pdf
5 MCII / GIZ (2018): Advancing Climate Risk Insurance Plus. Source: http://www.climate-insurance.org/projects/advancing-climate-risk-insurance-acri/

6. DISCUSSION

Globally, weather extremes are occurring at increased frequency, as a result of anthropogenic climate change. Also in Germany, measurements show that yearly temperature averages are increasing, and rainfall patters changing, accompanied by long heat waves, flooding, and storms. Rural and urban areas require tailored approaches to reduce the risks of physical, social and economic losses, depending on their topography, specific climatic conditions, population density, and typology of built up structures.

Large cities and agglomerations, as hubs of infrastructure, economic growth and innovation, are major contributors to GHG emissions compared to rural regions, while being especially prone to climate impacts, affecting a large number of citizens and built up structures at the same time. Climate sensitive development in municipalities therefore requires a two-legged approach, targeting climate mitigation and adaptation measures at the same time, while taking other issues – such as population growth, and accompanying matters of urban extensions, renewal, brownfield developments – into account. This requires integrated, comprehensive and cross-sectoral planning strategies that address mitigation and adaptation measures not as an isolated silo, but a challenge to be integrated throughout all matters of urban development planning.

Creation of targeted measures for climate adaptation require preceding vulnerability and risk assessments, embedded within a comprehensive climate risk management strategies. As investments in adaptation infrastructure are often implemented over long-term and bring high financial and administrative responsibilities with them, risk analyses can avoid false decision-making, and define the priorities of relevant target areas. While the Federal government provides a vulnerability analysis for the whole country, every city and town needs to conduct a separate assessment, tailored to their individual conditions. As models for climate risk assessment show, such analyses are not a static process, but require constant advancement, including feedback of all public and private stakeholders and reacting towards changes in conditions and new findings.

Germany's Federal Government, the subnational governments and municipalities are aware of the increasing risk that comes with a rapidly changing climate. Since the Federal adaptation strategy, DAS, has been adopted in 2008, a number of policies and strategies have been developed and successfully implemented throughout Germany. Federal programmes specifically targeting climate adaptation in urban environments, support municipalities in realisation of concrete projects. While mitigation measures and subsidy funds are already mainstreamed throughout Germany, the adaptation sector is slowly gaining momentum. Despite many large and medium sized cities in the country having developed adaptation strategies, realisation of projects requires additional efforts.

Here, for effective implementation, the most crucial level in cities are districts and neighbourhoods. As projects, such as the climate strategy of Bottrop, have shown, it is the district and neighbourhood level where the success of mitigation and adaptation measures is decided. In many cases, especially regarding mitigation measures, a rethinking of individual, local resident's mindset is required, to adhere to emission-free modes of mobility, implementation of energy efficiency measures and behaviours in their own homes, and acceptance of large-scale projects in their immediate surroundings. Also for adaptation projects in municipalities, early involvement of local citizens, and the possibility for continuous feedback is pivotal for long-term success.

In many cases, adaptation measures require implementation or transformation of protective infrastructure, and often entail changes of the physical urban fabric. Besides reducing the risks of climate related hazards, investments in adaptation measures can create additional value for local residents, and by that reduce potential barriers for the implementation process. For instance, by enhancing green infrastructure in urban neighbourhoods, aiming to create natural retention areas and cooling down temperatures, also new recreational spaces are established, enhancing accessibility of green areas and thus quality of life for locals. This paradigm contributes to understanding adaptation measures not only as a reaction to climate change, but also use them as an opportunity to improve liveability of urban environments for residents.

7. REFERENCES

adelphi / PRC / EURAC (2015): Vulnerabilität Deutschlands gegenüber dem Klimawandel. Umweltbundesamt. Climate Change 24/2015, Dessau-Roßlau. Source: https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/climate_change_24_2015_vulnerabilitaet_deutschlands_gegenueber_dem_klimawandel_1.pdf

BBSR (2017): CO2-neutral in cities and neighbourhoods – the European and international perspective. Bonn. Source: https://www.bbsr.bund.de/BBSR/EN/Publications/OnlinePublications/2017/bbsr-online-10-2017-dl.pdf?__blob=publicationFile&v=3

BBSR (2018): ExWoSt Forschungsfelder – Klimaresilienter Stadtumbau. Source: https://www.bbsr.bund.de/BBSR/DE/FP/ExWoSt/Forschungsfelder/2017/klimaresilienter-stadtumbau/01-start.html?nn=430172

BMU (2008): German Strategy for Adaptation to Climate Change. Source: https://www.bmu.de/fileadmin/bmu-import/files/english/pdf/application/pdf/das_gesamt_en_bf.pdf

BMU (2011): Adaptation Action Plan I; Source: https://www.bmu.de/fileadmin/bmu-import/files/pdfs/allgemein/application/pdf/aktionsplan_anpassung_klimawandel_en_bf.pdf

BMU (2016): Adaptation to Climate Change. Initial Progress Report by the Federal Government on Germany's Adaptation Strategy. Berlin. Source: https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/fortschrittsbericht_anpassung_klimawandel_en_bf.pdf

BMU (2016): Climate Action Plan 2050. Principles and goals of the German government's climate policy. Berlin. Source: https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf

BMU (2018): Nationale Klimaschutzinitative. Förderprogramm Kommunalrichtlinie. Source: https://www.klimaschutz.de/kommunalrichtlinie

BMU (2018) Nationale Klimaschutzinitiative. Zahlen und Fakten. Source: https://www.klimaschutz.de/zahlen-und-fakten

BMU (2018) Internationale Klimaschutzinitiative. Förderinstrument IKI. Source: https://www.international-climate-initiative.com/en/about-the-iki/iki-funding-instrument/

BMU (2018): 10 Years IKI – Facts and Figures. IKI funding volume by funding area 2008 – 2017. Bonn. Source: https://www.international-climate-initiative.com/fileadmin/Dokumente/2018/10IKI_Facts_Figures_NEU.pdf

BMZ (2017): InsuResilience. Klimarisikoversicherungen für arme und verwundbare Menschen in Entwicklungsländern. Berlin / Bonn. Source: http://www.bmz.de/de/zentrales_downloadarchiv/klima_und_cop23/BMZ_Infoblatt_InsuResilience.pdf

Brasseur, Guy (Ed.) et al. (2017): Klimawandel in Deutschland. Entwicklung, Folgen, Risiken und Perspektiven. Springer, Berlin. Source: http://oceanrep.geomar.de/34663/1/bok_978-3-662-50397-3.pdf

City of Essen (2017): Essen 2017. Application for European Green Capital. Climate change: mitigation and adaptation. Source: http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2015/06/01_Application-EGC-2017_Climate-Change_ESSEN.pdf

City of Essen (2017): Essen 2017. Municipal Green Areas that incorporate Sustainable Land Use. Source: http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2015/06/03_Application-EGC-2017_Green-Areas_ESSEN.pdf

Christian Kind and Katharina Sartison (2017): Wie deutsche Städte sich an den Klimawandel anpassen. Source: https://www.umweltbundesamt.de/themen/wie-deutsche-grossstaedte-sich-an-den-klimawandel

Climate-KIC (2018): Climate-KIC. Source: http://climate-kic.de/%C3%BCber

Deutscher Städtetag (2012): Positionspapier Anpassung an den Klimawandel. Empfehlungen und Maßnahmen der Städte. Köln. Source: http://www.staedtetag.de/imperia/md/content/dst/positionspapier_klimawandel_juni_2012.pdf

Difu (2018): Die nächste Hitzewelle kommt bestimmt: Wir müssen handeln! In: Difu-Berichte 4/2018. Source: https://difu.de/node/12282?fbclid=IwAR0zXhwC-mAfkgmdabTqK_mscJx6Aw6tm-MikHV1Pig6fcHX4X8AifuOg3Q

EEA (2016): Urban adaptation to climate change in Europe 2016. Transforming cities in a changing climate. Luxembourg. Source: https://www.eea.europa.eu/publications/urban-adaptation-2016

European Institute of Innovation % Technology (2018): Moabit West, Berlin. Source: https://www.climate-kic.org/success-stories/moabit-west-berlin

European Institute of Innovation & Technology (2018): EIT Climate-KIC. Source: https://eit.europa.eu/eit-community/eit-climate-kic

European Green Leaf (2016): 2017 EGCA Shortlist. Source: http://ec.europa.eu/environment/europeangreencapital/applying-for-the-award/2017-egca-applicant-cities/index.html

Jolk, Anna-Kristin (2015): Gut kombiniert: Klimaschutz und Klimaanpassung in Kommunen. In: Klimaschutz & Klimaanpassung. Wie begegnen Kommunen dem Klimawandel? Köln. Source: http://edoc.difu.de/edoc.php?id=OTSJ58R4

MCII / GIZ (2017): Increasing Resilience through Integrated Climate Risk Management. Source: http://www.climate-insurance.org/fileadmin/mcii/pdf/ACRI_/ACRI__ICRM_Factsheet_final.pdf
MCII / GIZ (2018): Advancing Climate Risk Insurance Plus. Source: http://www.climate-insurance.org/projects/advancing-climate-risk-insurance-acri/

Müller, Bernhard (ed.) (2013): Risiken beherrschen, Chancen nutzen. Die Region Dresden stellt sich dem Klimawandel.

Parry, M.L. et al. (2007): Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers. Source: http://www.un-documents.net/ipcc-ar4/wg2-spm.pdf

Projektträger Jülich (2018): Förderung von Maßnahmen zur Anpassung an die Folgen des Klimawandels. Source: https://www.ptj.de/folgen-klimawandel

REGKLAM-KONSORTIUM (ed.) (2013): Risiken beherrschen, Chancen nutzen. Die Region Dresden stellt sich dem Klimawandel. Strategiekonzept zum Integrierten Regionalen Klimaanpassungsprogramm für die Region Dresden. Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/Strategiekonzept_130924_final_online.pdf

REGKLAM-KONSORTIUM (ed.) (2013): Integriertes Regionales Klimaanpassungsprogramm für die Region Dresden. Grundlagen, Ziele und Maßnahmen. Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/Grundlagen_Ziele_Ma%C3%9Fnahmen_v2.0_final_online.pdf

Senatsverwaltung für Stadtentwicklung und Wohnen Berlin (2013): Stadtteilentwicklungskonzept GREEN MOABIT – Bericht. Source: https://www.stadtentwicklung.berlin.de/staedtebau/foerderprogramme/stadtumbau/fileadmin/user_upload/Dokumentation/Projektdokumentation/Mitte/FG_Moabit_Nordring_Heidestr/D6_Green_Moabit/PDF/Green_Moabit_Bericht.pdf

Senatsverwaltung für Stadtentwicklung und Wohnen Berlin (2018): Stadtteilentwicklungskonzept Green Moabit. Source: https://www.stadtentwicklung.berlin.de/staedtebau/foerderprogramme/stadtumbau/D6-Green-Moabit.6368.0.html

Sieker (2018): Das Konzept der Schwammstadt (sponge-city). Source: https://www.sieker.de/de/fachinformationen/umgang-mit-regenwasser/article/das-konzept-der-schwammstadt-sponge-city-577.html

Travis, W., Bates, B. (2014): What is climate risk management? In: Climate Risk Management 1. 1-4. Source: https://www.sciencedirect.com/journal/climate-risk-management/vol/1

TU Dresden (2013): Faktenblatt Klimawandel Dresden. Signale für die Klimaentwicklung von Dresden. Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/130122_Faktenblatt_Klimawandel-Dresden.pdf

TU Dresden (2013): Faktenblatt Regionaler Klimawandel. Regionale Klimaszenarios für die Modellregion Dresden. Source: http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/130122_Faktenblatt_regionaler-Klimawandel.pdf

UBA (2011): Versicherungen. In: THEMENBLATT: Anpassung an den Klimawandel, Dessau-Roßlau. Source: https://www.umweltbundesamt.de/sites/default/files/medien/364/publikationen/kompass_themenblatt_versicherung_2015_net.pdf

UBA (2016): KLIMZUG – Klimawandel in Regionen zukunftsfähig Gestalten. Source: https://www.umweltbundesamt.de/themen/klima-energie/klimafolgen-anpassung/werkzeuge-der-anpassung/projektkatalog/klimzug-klimawandel-in-regionen-zukunftsfaehig

UBA (2017): Dauerregen in Deutschland: Wie können wir vorsorgen? Source: https://www.umweltbundesamt.de/themen/dauerregen-in-deutschland-wie-koennen-wir-vorsorgen

Weiland, Ulrike (2018): Stadt im Klimawandel. In: bpb - Dossier Stadt und Gesellschaft. Source: http://www.bpb.de/politik/innenpolitik/stadt-und-gesellschaft/216883/stadt-im-klimawandel

DISCLAIMER

Title:

Keystone Papers for the key topics of the Sino-German Urbanisation Partnership

Imprint

The keystone papers are published as part of the "German-Chinese Urbanisation Partnership". As part of the International Climate Initiative (IKI), the project is commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in cooperation with the Ministry of Housing and Urban-Rural Development of the People's Republic of China.
As a federal company, GIZ supports the German Federal Government in achieving its goals in international cooperation for sustainable development.

Editor:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Sitz der Gesellschaft
Bonn und Eschborn
Sunflower Tower
Maizidian Str. 37, Chaoyang District
100125 China, Beijing
T +86 10 85275180, F +86 10 85275185
E giz-china@giz.de
I www.giz.de/china , www.sustainable-urbanisation.org/en

Editorship:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Peter Sailer, Xueling Liu, Jia Fu, Yunqing Bi

Main authors:

Happold Ingenieurbüro GmbH
Pfalzburger Straße 43-44
10717 Berlin, Germany
Thomas Kraubitz, Peter Scheibstock, Gabriela Guillen,
Joachim von Bergmann

Coordination and Responsibility:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Peter Sailer

Layout, graphics:

Happold Ingenieurbüro GmbH
Pfalzburger Straße 43-44
10717 Berlin, Germany

Disclaimer

On behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

CLIMATE RISK MANAGEMENT IN CITIES

Sino-German Urbanisation Partnership

Keystone Paper for the key topics of the Sino-German Urbanisation Partnership

Editor:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Main Authors & Layout:

BUROHAPPOLD ENGINEERING

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany