TEACHER-CE

PILOT ACTION UPPER LUSATIA (PA2)
OUTPUT O.T3.4

WORK PACKAGE T3 - IMPLEMENTATION AND FEEDBACK - TOOLBOX VERIFICATION

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1. Introduction

Increasing weather extremes affect water balance and water quality. In the Pilot Region of Lower Silesia several heavy rain events have caused significant damages in the past years. Therefore, part of the region was already involved in the previous project RAINMAN. Since then, a period of extreme drought has shown further problems for the water availability in the region. Consequential effects have been documented for ground water management, forestry and agriculture as well as drinking water supply.

In TEACHER-CE the pilot action of Lower Silesia is aiming on reduction of high damages/losses caused by heavy rainfall or drought. The applied tools from the RAINMAN project have been jointly evaluated with the stakeholders and gaps were identified. Land-use management practises on different levels and fields of actions were put into focus and improved.

The process was accompanied by the use and testing of the Integrated Toolbox CC-ARP-CE (in cont. toolbox).

The goal of the toolbox is to create an adaptable solution for all stakeholders in the different countries and counties. Therefore, the testing of the toolbox beta version by project partners (PPs) in pilot actions (PAs) is an important step in the development phase and provides:

- documented learning experience, where PPs from different countries and disciplines will verify the Toolbox applicability and
- an important communication tool where project results will enable important outreach and key post-project capitalization leverage supporting bottom-up participatory principles in water management planning processes, generally drafted by the Common Implementation Strategy for the Water Framework Directive (WFD CIS No.11).

The toolbox was also tested by stakeholders during training workshops and in the post-training implementation phase, when strategies were discussed. These stakeholder interactions clarified needs and provided recommendations for toolbox improvements (bottom-up approach) and for direct local and regional implementation of the toolbox.

2. Basic data about PA2

The area of Upper Lusatia spans a large part of Eastern Germany – it covers an area from the southern borders of Brandenburg to the whole eastern part of Saxony almost to its federal capital Dresden (about 4500 km²). With respect to the location of and cooperation with our ASP, we limited the pilot action area to the County of Görlitz, which is described in the following.

2.1. Geographical description

The county of Görlitz is located in the very eastern part of Germany, belongs to the German federal state of Saxony and is part of the three-country triangle Germany-Poland-Czech Republic. It's landscape changes from north to south. In the north, the county is almost flat (98 m a.s.l.) whereas it becomes hilly towards the south and has the Zittau Mountains with its highest peak "Lausche" (793 m a.s.l.) located in the very south. The rural county is characterized by agricultural land use and has an area of 2.111 km² with about 250.000 inhabitants. The largest cities are Görlitz with 56.000 inhabitants and Zittau with 26.000 inhabitants.

Figure 1: County of Görlitz with boards to the Czech Republic (south) and Poland (east) (source: Berwig, 2020)

2.2. Climate characteristics

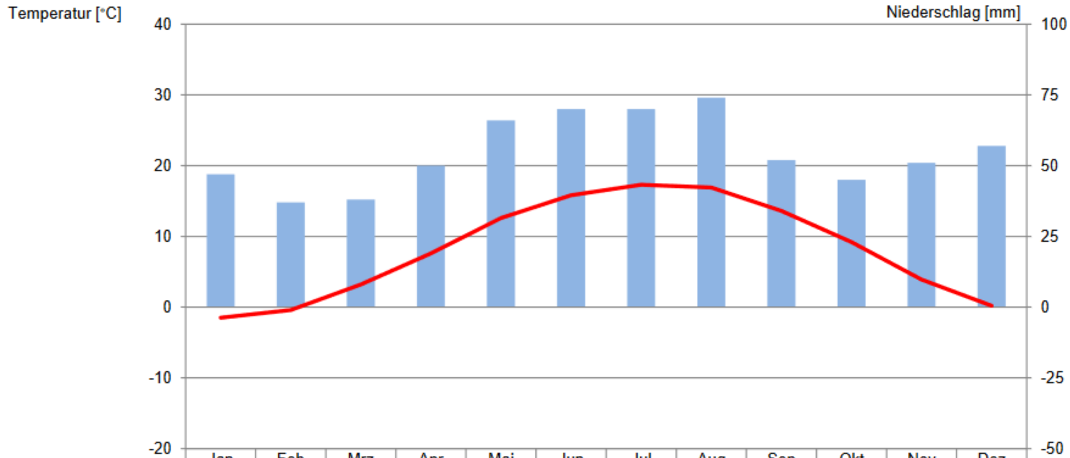
According to the Köppen-Geiger climate classification system, the County of Görlitz is located in Cfb (C – temperate climate, f – humid, b – warm summer). Depending on the large-scale weather situation, long dry periods in summer and long periods of frost days can occur, meaning that the pilot area is also influenced by continental climate can be hence classified as Dfb (D – continental climate, f – humid, b – warm summer).

The annual mean temperature is 9.2 °C, the annual mean precipitation 645 mm. In mountain areas precipitation can rise up to 800-1000 mm. The wettest as well as warmest months are June, July and August with an average of 18°C (reference period 1990 -2019, source: ReKIS data). A map of all climate stations and their operators can be found in Annex 7.1.

The following figure shows the climate diagram of Görlitz, the largest city in the county:

Klimadiagramm von Görlitz, Niederschlesischer Oberlausitzkreis, Sachsen / Deutschland

Koordinaten: geographische Breite: 51° 10' N, geographische Länge: 14° 57' E   Stationshöhe: 237 m über NN



	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez
Niederschlag, mittl. Monatssumme [mm]	47	37	38	50	66	70	70	74	52	45	51	57
Temperatur, Monatsmittel [°C]	-2	0	3	8	13	16	17	17	14	9	4	0

Figure 2: Climate diagram of Görlitz (source DWD) [1]

2.3. Hydrology

2.3.1. Surface waters

In addition to the Lusatian Neisse River in the east and the Spree River in the west, the Mandau, the Löbauer Wasser as well as the White and Black Schöps rivers run through the county. With the lakes Bärwalder See, Berzdorfer See and the Quitzdorf dam, the county of Görlitz has some of the largest stagnant waters in Saxony.

The Lusatian Neisse is the largest river in the county and forms a natural border between Germany and Poland as well as a short natural border between Germany and the Czech Republic. After entering in the Oder river, the waterbody empties into the Baltic Sea.

The Spree river is one of the largest rivers in the region. It rises as a small stream, but develops to a large river, which later on crosses the German capital city Berlin and counts as one of the important rivers in Germany. In the county of Görlitz, the water course of the Spree river has been changed due to brown coal mining in the past. In the northern parts of the county, the Spree river partially has a brownish discoloration due to iron hydroxide ochre because of brown coal mining and groundwater level rise. Also, sulfate load is often above drinking water limits.

The Mandau is one of the watercourses in the southern Upper Lusatia, which is characterized by a very irregular water flow. It flows via the Lusatian Neisse into the Oder river into the Baltic Sea.

The Löbauer Wasser is a right tributary of the Spree river. It originates from the confluence of the smaller rivers Großschweidnitzer Wasser and Cunnersdorfer Wasser. It flows via the Spree river into the Havel river, Elbe river into the North Sea.

The springs of Black and White Schöps are just a few kilometres apart from each other. They both flow into north-western direction. The river course of the White Schöps was canalized and relocated to make brown coal mining possible. The White Schöps flows into the Black Schöps, from where it flows via the Spree, Havel and Elbe river into the North Sea. For a map see Annex, Chapter 7.2.

[1] Source: https://www.dwd.de/DWD/klima/beratung/ak/ak_104990_di.pdf

Table 1: Average water levels (source: LfULG, 2020)

	Ø low water level [cm]	Ø water level [cm]	Ø high water level [cm]	Ø highest water level [cm]
Lusatian Neisse (Görlitz)	139	176	420	720
Spree (Ebersbach)	98	194	209	305
Mandau (Zittau)	27	43	172	200
Löbauer Wasser (Großschweidnitz)	6	13	126	256
Schwarzer Schöps (Boxberg)	102	131	276	457
Weißer Schöps (Särichen)	31	57	191	260

Table 2: Average discharges (source: LfULG, 2020)

	Ø low water discharge [m^3/s]	Ø discharge [m^3/s]	Ø high water discharge [m^3/s]	Ø highest water level discharge [m^3/s]
Lusatian Neisse (Görlitz)	4.87	16.9	179	1010
Spree (Ebersbach)	0.081	0.227	6.07	27.9
Mandau (Zittau)	0.438	2.12	38.7	53.1
Löbauer Wasser (Großschweidnitz)	0.09	0.335	13.7	70.0
Schwarzer Schöps (Boxberg)	1.73	4.68	26.0	76.0
Weißer Schöps (Särichen)	0.116	0.808	15.1	34.6

2.3.2. Flooding

Significant floods at the Lusatian Neisse occurred in October 1981 and in 2010. In 1981, long-lasting rainfalls caused floods in almost the whole county. The water level in Görlitz rose to 6.87 m. In 2010, a low pressure system over Northern Italy caused partly heavy continuous rainfall throughout the entire Free State of Saxony from August 6 to 8. In the south of the county of Görlitz, emergency alarm was triggered after the level of the Lusatian Neisse rose dramatically. This situation was partly caused by a rupture of the dam wall of the Witka Reservoir located in Poland. Within a few hours, the level of the Neisse in Görlitz rose to over 7 meters. About 1000 people had to be evacuated. The Mandau river, Black and White Schöps as well as other parts of the Spree catchment area were also affected by this flood event.

In 2013, another big flood event affected large areas of Saxony. Again, it was triggered by long-lasting high intensity precipitation events under atmospheric low pressure conditions. This flood event affected all rivers in the county and caused damages of 50 Mio. Euro.[2] For a flood map of HQ100 events see Annex, Chapter 7.3.

[2] Source: https://www.saechsische.de/plus/50millionen-euro-schaden-im-landkreis-nach-dem-hochwasser-2013-3961737.html

2.3.3. Heavy rain

Heavy rainfalls with far-reaching impacts for the whole county occurred in 2010 and 2013 (cf. Chapter 2.32)

Flash floods occur after short and locally very limited heavy rainfall events, causing high damage in certain villages and towns along small streams and rivers, especially in hilly or mountainous terrain, or flooding large areas in the lowlands. The county of Görlitz has the highest amount of heavy rainfall events in whole Saxony. Between 2002 and 2017, the county was affected 86 times. The damages per building amount to 11.778,00 Euro on average.[3]

2.4. Hydrogeology

The northern and central parts of the county are covered with loose rock deposits of glacial origin (sands and gravel, boulder clay, alluvial material and loess) and only rarely does the solid rock come to light. Towards the south the thickness of the loose material decreases and the substrate consists of weathering residues of the solid rocks.

Hydrogeological characteristics change from the north to the south. The north is characterized by the Lusatian Cenozoic, the middle of the county by the Lusatian granodiorite complex and the south by the Elbe valley trench. The north has highly productive porous aquifers, whereas the middle and the south mostly have non-aquiferous rocks except for the Elbe valley trench which has highly productive fissured aquifers, including karstified rocks. The northern and northern-east parts as well as along the Lusatian Neisse the yields of groundwater deposits are very rich. Single wells can carry more than 40 l/s and waterworks more than 5 hm^3/a. In all other parts of the county, single wells can carry between 2 – 15 l/s. In one half of the county, the yield of groundwater deposit is not or less significant and the operation of waterworks is (strictly) limited. The amount of groundwater recharge varies a lot all over the county. Especially in the north, where the landscape is influenced by brown coal mining, the value ranges between 0 and 250 mm/a within only few kilometers distance. In most regions of the county groundwater recharge ranges between 75-100 mm/a. For detailed maps on aquifer types, yield of groundwater deposit and groundwater recharge see Annex, Chapter 7.4.

2.5. Land use and forestry

The county of Görlitz is a very rural county and characterized by agricultural land use. It is covered with 35 % forests and 42 % farmland. The total usable agricultural area amounts to 89.337 ha. For a land use map see Annex, Chapter 7.5.

Forestry: According to the altitude classification, the following sequence is characteristic: oak and pine mixed forests in the lowlands, (lime-rich) hornbeam oak forests in the loess belt, oak and beech mixed forests in the mountains. This rough distribution is interrupted by special, small-scale site conditions, e.g. in river valleys, on mountain tops or specific substrates.

2.6. Protected areas

The county of Görlitz has many bird protection-, nature conservation- and FFH areas. Additionally, the Zittau Mountains in the south of the county are protected as a nature park. It covers an area of 133 km^2. For a map of protected areas see Annex, Chapter 7.6.

[3] Source: https://www.gdv.de/de/themen/news/890-millionen-euro-starkregen-schaden-in-sachsen---goerlitz-am-haeufigsten-betroffen-52810

Bird protection areas: Biosphärenreservat Oberlausitzer Heide- und Teichlandschaft, Doras Ruh, Feldgebiete in der östlichen Oberlausitz, Muskauer und Neustädter Heide, Neißetal, Talsperre Quitzdorf, Teiche und Wälder um Mückenhain, Teichgebiete Niederspree-Hammerstadt, Zittauer Gebirge

FFH areas: Basalt- und Phonolithkuppen der östlichen Oberlausitz, Doras Ruh, Eichgrabener Feuchtgebiet, Feuchtgebiete und Wälder bei Großsaubernitz, Fließgewässer bei Schöpstal und Kodersdorf, Hochlagen des Zittauer Gebirges, Hohe Dubrau, Laubwälder der Königshainer Berge, Mandautal, Monumentshügel, Neißegebiet, Niederspreer Teichgebiet und Kleine Heide Hähnichen, Oberlausitzer Heide- und Teichlandschaft, Pließnitzgebiet, Schwarzer Schöps oberhalb Horscha, Separate Fledermausquartiere und -habitate in der Lausitz, Spreegebiet oberhalb Bautzen, Stauwurzel, Teiche und Wälder an der Talsperre Quitzdorf, Täler um Weißenberg, Teiche bei Moholz, Teiche und Feuchtgebiete nordöstlich Kodersdorf, Ullersdorfer Teiche

Nature conservation areas: Altes Schleifer Teichgelände, Georgewitzer Skala, Hammerlugk, Hengstberg, Hermannsdorf, Hochstein, Hohe Dubrau, Innenkippe Nochten, Jonsdorfer Felsenstadt, Keulaer Tiergarten, Landeskrone, Lausche, Loose, Monumentshügel, Niederspreer Teichgebiet und Kleine Heide Hähnichen, Oberlausitzer Heide- und Teichlandschaft, Rotstein, Rutschung P, Schleife, Schönbrunner Berg, Südbereich Braunsteich, Talsperre Quitzdorf, Trebendorfer Tiergarten

2.7. Drinking water sources and protection

Drinking water is extracted from the following sources: 70 % from groundwater, 13 % from spring water, 12 % from bank filtrate and 5 % from enriched groundwater[4].

As the county is a large region, it is supplied by several waterworks: Schwarze Pumpe, Boxberg, Niesky, Görlitz, Neusalza-Spremberg, Johnsdorf, Johnsdorf-Drehe, Ebersbach, Großhennersdorf, Neugersdorf, Eichgraben and Duerrhennersdorf[5].

The average water consumption per person in Saxony is 86 l per day[6].

The map in Annex 7.7 shows drinking water protection zones. Zone I comprises the immediate area of water extraction within a radius of at least 10 m. This area must be protected against any intervention. There is an absolute prohibition of modifications here.

Zone II extends from zone I to a line from which the used groundwater will continue to flow for at least 50 days until the water catchment. This minimum retention period is intended to ensure the reduction of microbiological contamination and protection against other dangerous impacts (e.g. recontamination). Among other things, the application of liquid manure, slurry and silage leachate as well as any kind of soil modification, construction and relocation of sewer systems are prohibited.

Zone III covers the area from zone II to the catchment area boundary, which may be divided into protection zones III A and III B if it is more than 2 km apart from the catchment area. By intending to ensure that groundwater is protected from widespread pollution, in particular from non-degradable or poorly degradable chemical substances and radioactive contamination, the groundwater cover is to be largely maintained and the handling of substances hazardous to water is to be minimized. For example, new construction of industrial facilities, tank storage or oil pipelines is not permitted.

4 https://www.statistik.sachsen.de/genonline/online/data?operation=abruftabelleBearbeiten&levelindex=1&levelid=1607544428497&auswahloperation=abruftabelleAuspraegungAuswaehlen&auswahlverzeichnis=ordnungsstruktur&auswahlziel=werteabruf&code=32211-005K&auswahltext=&werteabruf=starten&nummer=7&variable=7&name=KRS50P

5 https://www.gesunde.sachsen.de/trinkwasser.php

6 https://publikationen.sachsen.de/bdb/artikel/26409/documents/42826

3. PA issues concerning TEACHER-CE topics

It was decided to set the thematic focus in the pilot area especially on the effects of rising temperatures and droughts as well as on heavy rain. The increasing weather extremes affect water balance and water quality.

Impacts of climate change will be especially addressed in the blue highlighted fields of water management, see Figure 3.

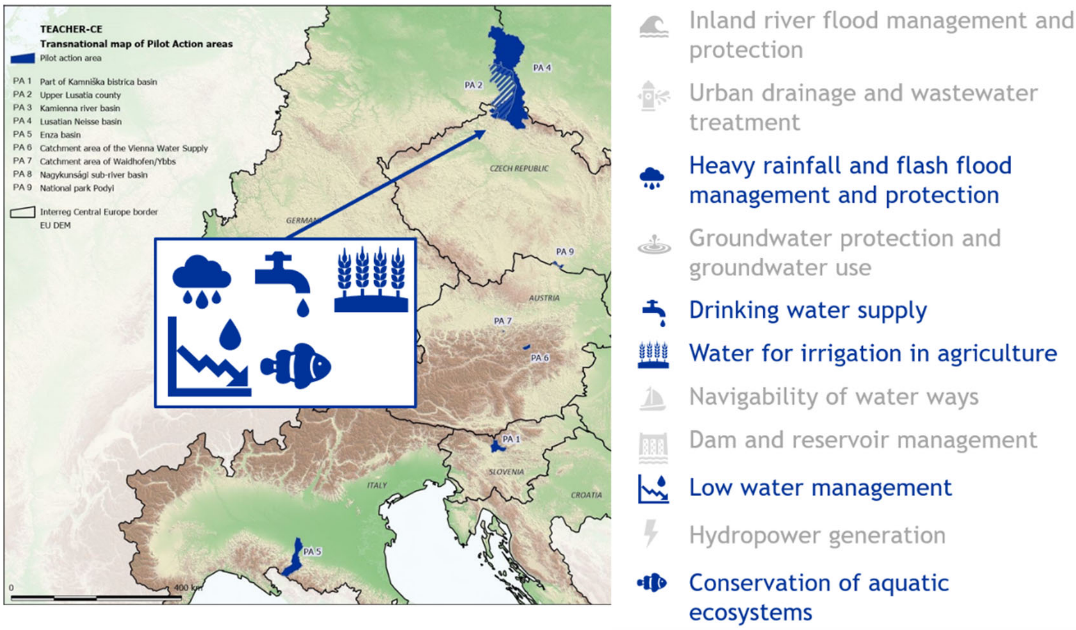


Figure 3: Thematic focus in PA2 (status: September 2020)

In-depth thematic consideration in the PA will be narrowed down further in the course of the project, if necessary.

3.1. Heavy rain

Severe flooding has been a frequent occurrence in this area in the past, and it is part of the social memory of the long-established villagers. However, there is the (subjective) impression that heavy rainfall in the recent past has become more frequent and more intense in this area. A key challenge of all risk management concepts would be to gain the audience to inform about impacts like flooding which is not dependent on a river no more. The sudden extreme precipitation events occur almost randomly putting areas in risk where no concerns have been made. The unawareness intensifies the danger but turns into a general demand of action-policies due to recent happenings. Especially in the southern hilly and mountainous parts of the county, heavy rainfalls are characterised by convective thunderstorms in the early summer months with varying extent. Therefore, the ASP 16 – City of Zittau has commissioned the development of a heavy rain concept with a first attempt of applying the toolbox.

The main limitation of existing tools is their dispersion and the missing acknowledgement of potential users concerning usage and even their existence. Tests of some tools e.g. RAINMAN-Toolbox have been applied only locally and results still have to be spread on a regional/national level.

Information on potential impacts of climate change on water management is shown for PA. Risks from and adaptation to pluvial and fluvial floods are a focus in the PA.

3.2. Floods

Floods have caused enormous damage in Saxony in recent years and great efforts have been made to reduce the flood risk. Flood protection concepts and flood risk management plans for the larger water bodies are available.

Information on potential impacts of climate change on water management is shown for PA. Risks from and adaptation to pluvial and fluvial floods are a focus in the PA.

3.3. Heat and Drought

In regard of increasing drought, the effects of climate change are already noticeable. In comparison of the reference period 1971 - 2000 with 1990 - 2019, the annual mean temperature has increased while, on the other hand, annual mean precipitation has stagnated or even declined. Climate model calculations indicate that this trend is going to proceed in the next years and decades.

Especially the recent years 2018-2020 are characterized as “drought years” in Germany. Even larger rivers conduct shallow water levels and are not navigable. Dams and reservoirs tend to be partially empty more and more often. Water shortage has led to prohibition of water withdrawal from water bodies, e.g. farmers have to stick to official restrictions for irrigations on agricultural lands and the filling of swimming pools can be forbidden.

Information on potential impacts of climate change on water management is shown for PA. Risks from and adaptation to heat stress in urban areas and droughts are a focus in the PA.

3.4. Forest management

No focus in PA2

3.5. Drinking water sources protection

A continuous drought period leading to water shortage, nitrogen and fertilizers input from agricultural land use management as well as iron hydroxide ochre and sulfate inputs due to brown coal mining is the main threat to drinking water.

The impacts of climate change in the thematic area "drinking water sources" are considered in the pilot activity with the aspects of mining, drinking water use and irrigation in agriculture.

4. Testing of the TEACHER-CE toolbox CC-ARP-CE

Based on the testing of the toolbox beta version in PA 2, the following conclusions can be drawn:

- Does the Toolbox reach its goal as an identification platform for issues and measures and a discussion platform for stakeholders?
  - The toolbox is suitable as a documentation platform of local issues. The issues need to be identified before and can then be added to the toolbox. The process of adding new issues is quite easy. The display functions need to be adapted for regional scale issues.
  - Since measures are directly connected to the categorisation of an issue (field of action, landuse), the identification of suitable measures is uncomplicated for the user.
  - Due to language barriers and other options of discussing issues for the stakeholders working in the same pilot area (meetings, phone, emails etc.) the use as a discussion platform is viewed critically.
- What are the limitations - what stops stakeholders from providing information?
  - Users from administrations (at least in PA2) will only add information, that have been intensively discussed and are known to the public. The tool cannot be used to develop an idea about existing issues and use the tool as a “working instrument” in daily work.
- How is the user experience - do stakeholders know, how to use the toolbox and does it meet user expectations?
  - In PA 2 the toolbox can only be useful if information is available in national language. Furthermore, a starting point to the toolbox giving some guidance / explanations etc. would be needed to give orientation.
  - The toolbox might be used as a documentation platform of issues to create maps on the distribution of issues. Also, the catalogue of measures provides a good overview about suitable measures in different fields of action or for different land uses.

5. Synthesis of the National Stakeholder Workshop

The TEACHER-CE national stakeholder workshop in Saxony took place on 3rd November as an online workshop. The workshop aimed to present and discuss the TEACHER Toolbox CC-ARP-CE as well as the interim results of the pilot action in the district of Görlitz. Opportunities but also the challenges and barriers in the implementation of adaptation measures were discussed.

The workshop was divided into two parts. In the first part, the TEACHER-CE Toolbox and its main tools were presented and feedback from the participants - potential users of the Toolbox - was gathered. It was discussed how the toolbox could support stakeholders working in the water management sector to adapt to climate change. It was reviewed which tools of the Toolbox could be used in the field of water management, also the requirements for these tools and what improvements of the Toolbox are needed.

In the second part of the workshop, INFRASTRUKTUR & UMWELT (Stefanie Weiner and Anna Goris) presented an in-depth look at the challenges (issues) in the field of water management that exist in the pilot action. Interim results were presented with regard to potential adaptation measures and their assessment (voting). On the one hand, possibilities of heavy rain risk management through spatial planning instruments were presented (see Annex 7.8). On the other hand, the focus was on study results with regard to synergies of adaptation measures to heavy rain risks and heat stress/drought through water sensitive urban design (see Annex 7.9). In this context, the participants also discussed which role strategies can have for successful adaptation in the field of water management.

The fruitful discussion will be very helpful for the further development of the toolbox and will be considered for the project implementation.

6. Conclusions

The described pilot action of Lower Silesia was aiming on reduction of high damages/losses caused by heavy rainfall or drought. The applied tools from the RAINMAN project have been evaluated jointly with the stakeholders from the regions. Gaps were identified, that were connected with

a) Implementation problems of heavy rain risk reduction measures
b) Understanding the synergies between the adaptation measures for different climate risks, mainly combined measures for heavy rainfall and heat/drought.

In order to improve the land-use management practises regarding heavy rain risk prevention and heat exposure different levels and fields of actions were put into focus. In close cooperation with the stakeholders from the region two main results have been finalised, which can – after implementation - reduce the vulnerability towards climate risks in the region:

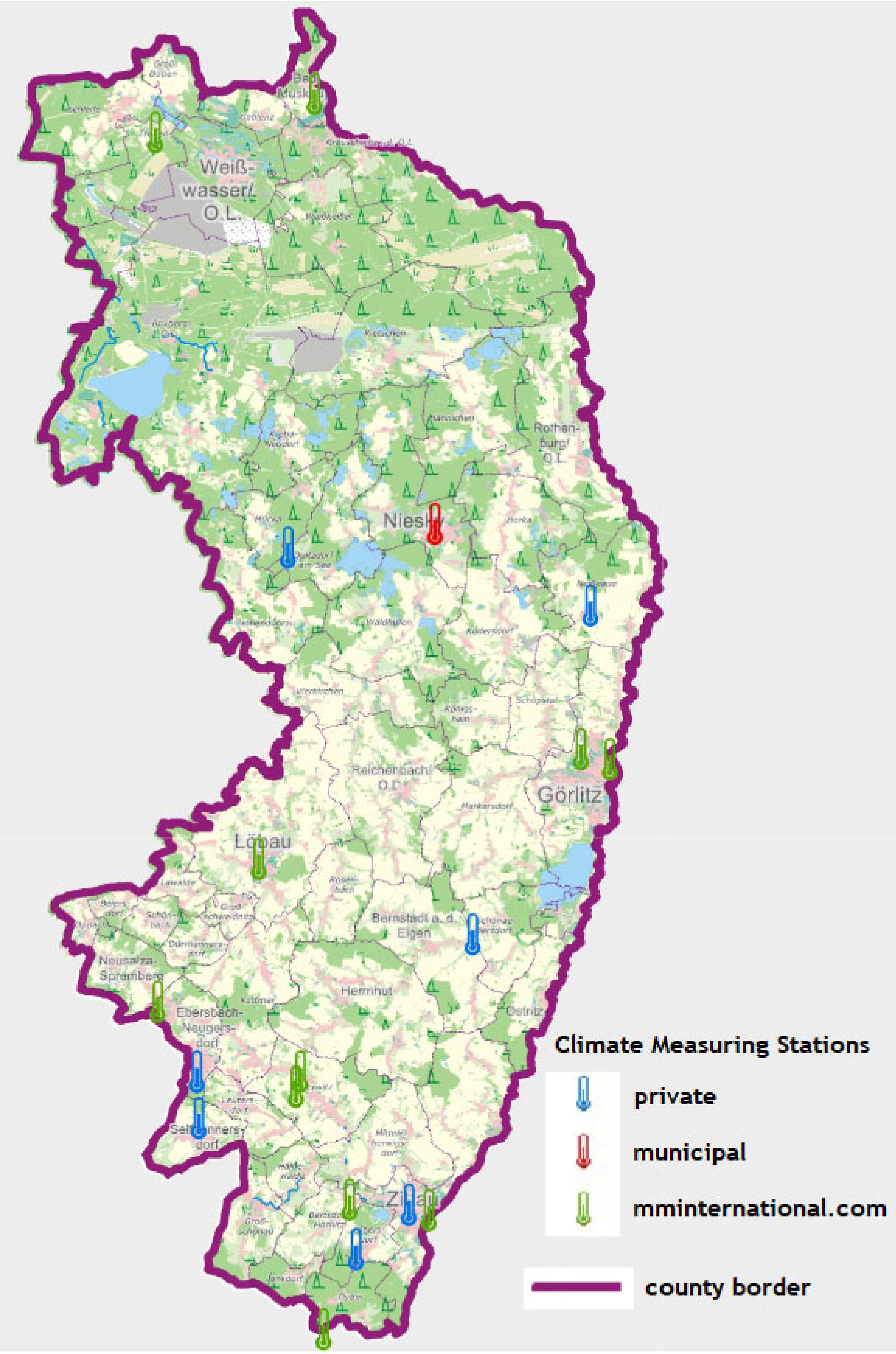
- A general guide for municipalities in the district of Görlitz on the integration of heavy rainfall prevention into municipal planning. Short version see Annex 7.8. (long version in German only)
- A local analysis of synergies of adaptation measures through water sensitive urban design. The analysis was undertaken for the focus area of Martin-Wehnert-Platz in Zittau. Short version see Annex 7.9. (long version in German only)

The pilot action was accompanied by the use and testing of the Integrated Toolbox CC-ARP-CE. Gaps between the direct participative development of adaptation decisions and the aided approach by using the toolbox were identified (see chapters 4 and 5).

All results have been entered into the Toolbox development process.

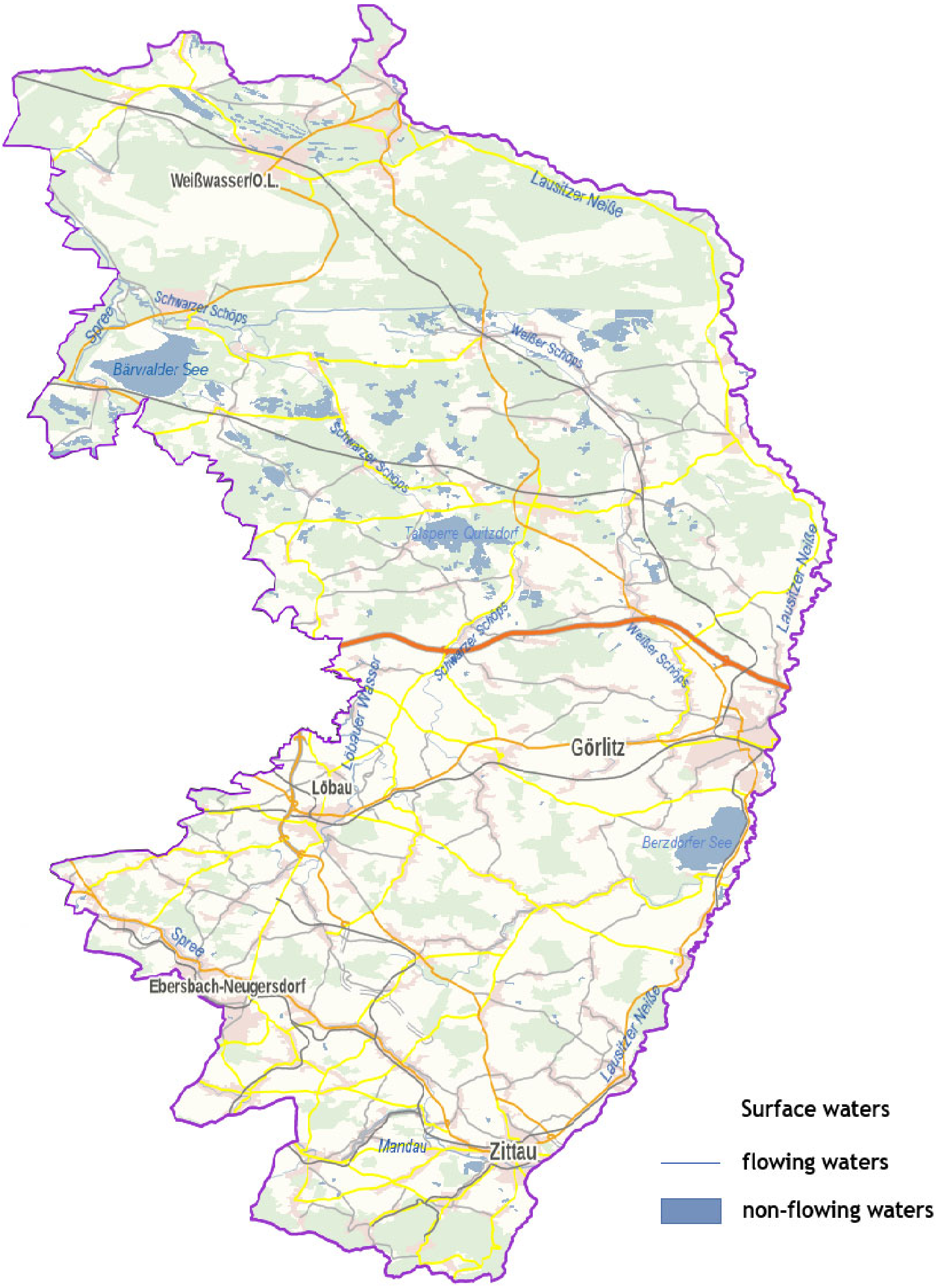
7. Annex

7.1 Climate Measuring Stations



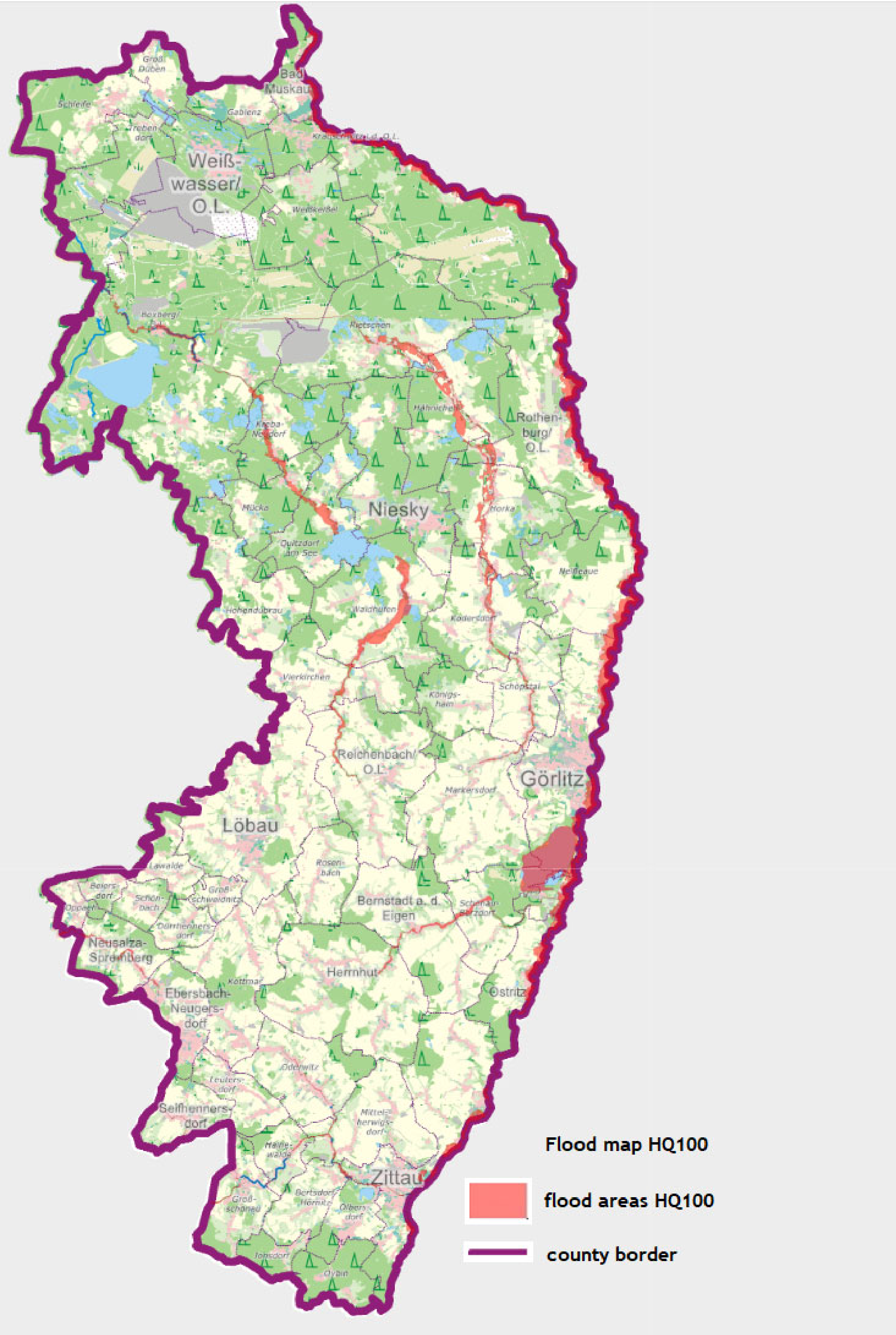
Source: © Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020) / LRA Görlitz - http://www.gis-lkgr.de, edited (Anika Albrecht, LfULG)

7.2 Surface waters



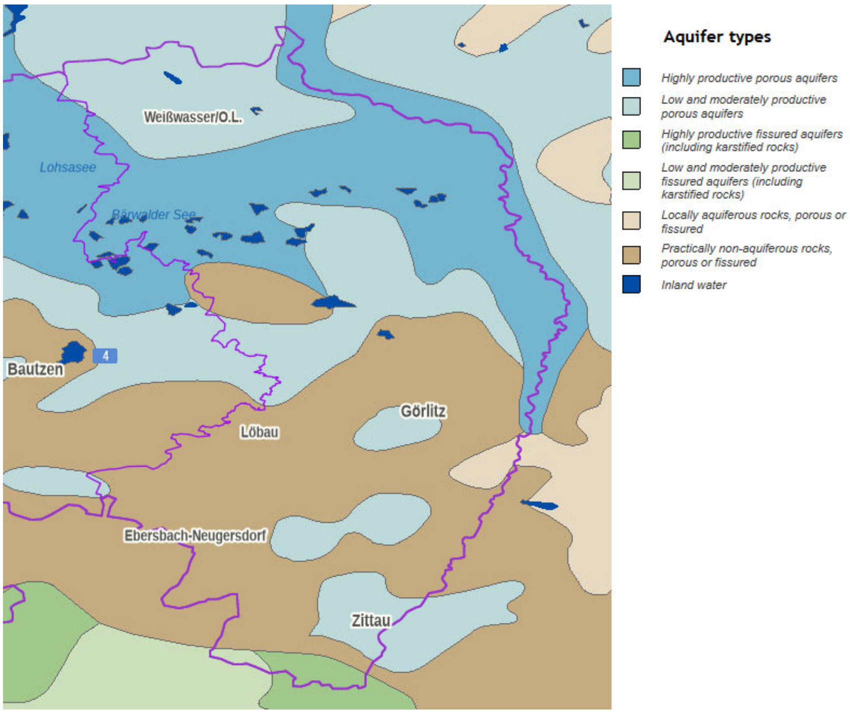
Source: © Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020), edited (Anika Albrecht, LfULG)

7.3 Flood map

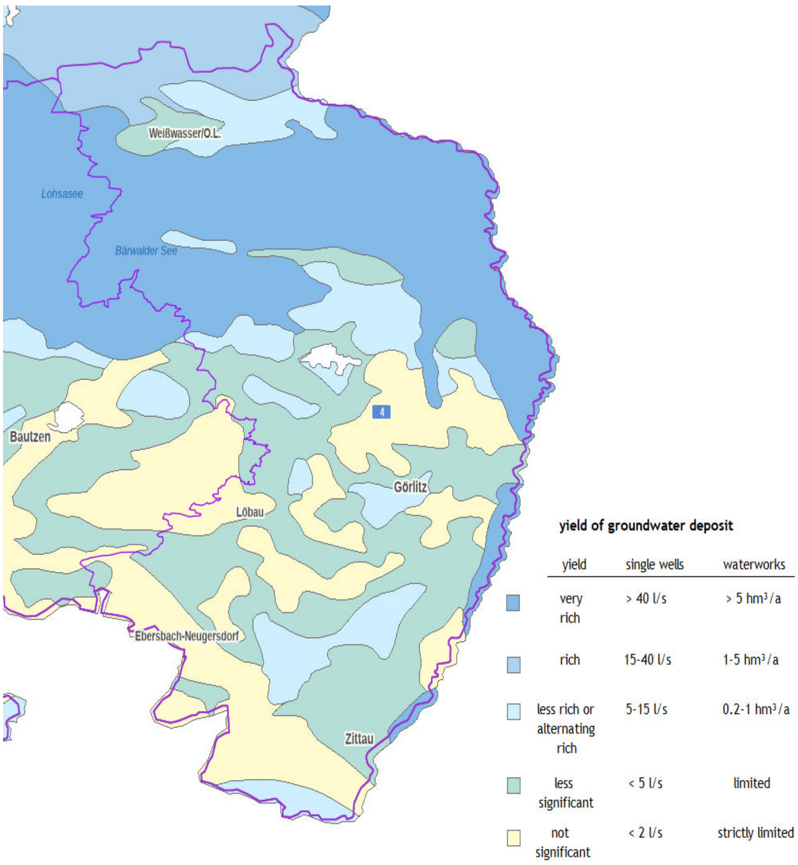


Source: Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020) / LRA Görlitz - http://www.gis-lkgr.de, edited (Anika Albrecht, LfULG)

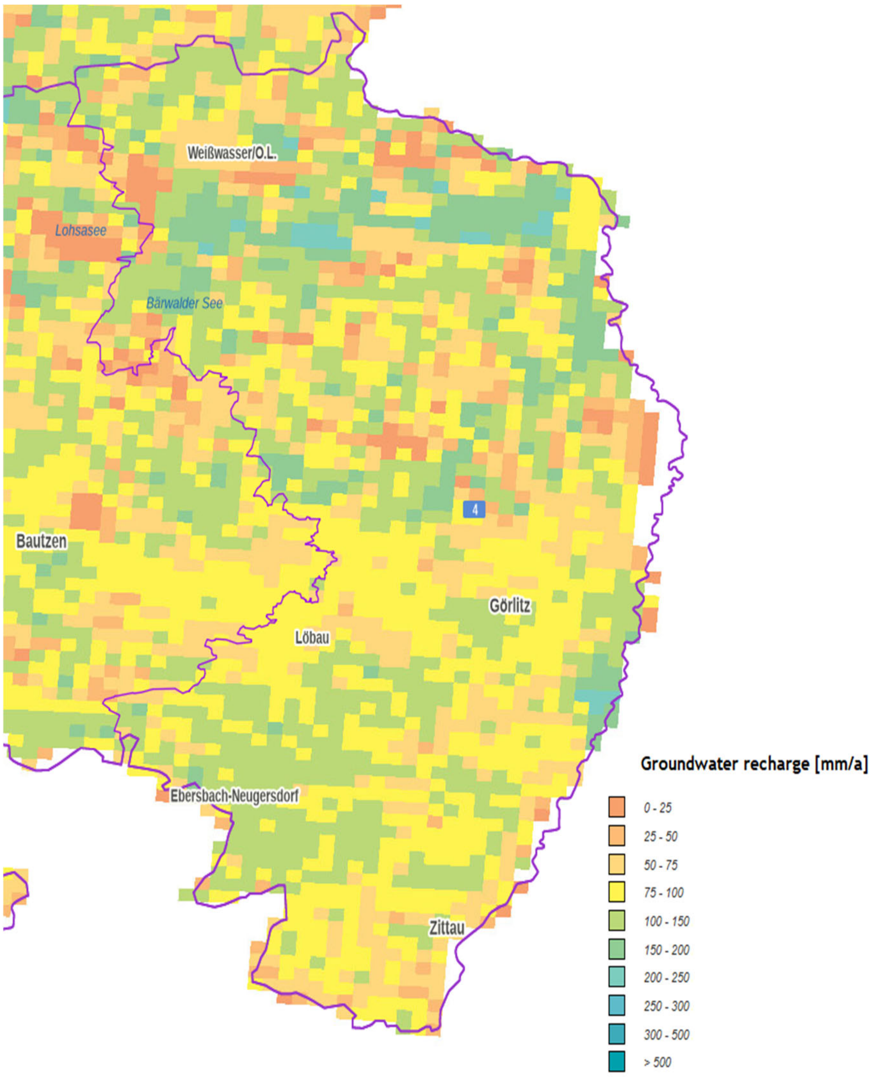
7.4 Hydrogeology



Source: Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020) and BGR IHME 1500 map v1.2, edited (Anika Albrecht, LfULG)

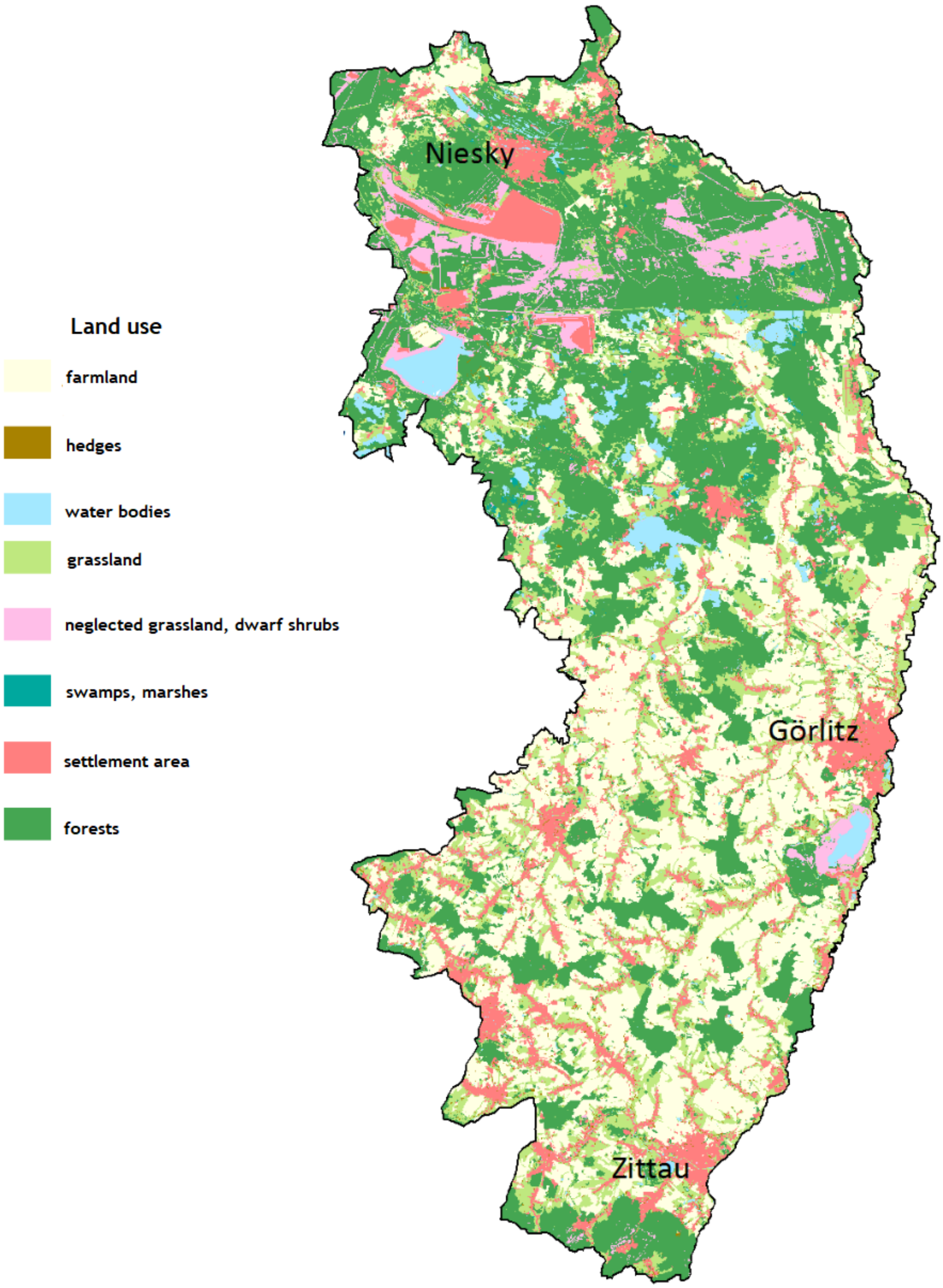


Source: Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020), edited (Anika Albrecht, LfULG)



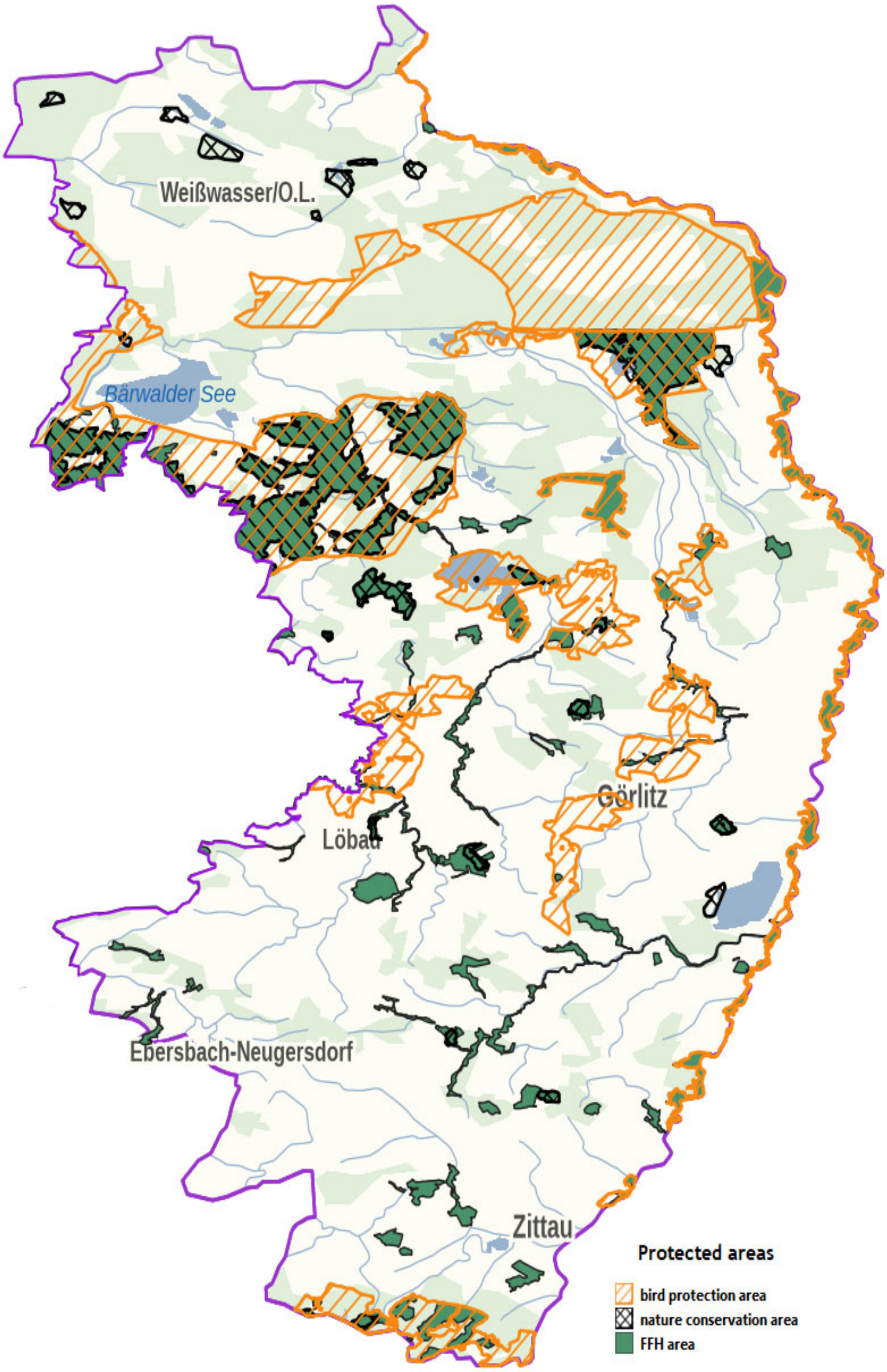
Source: Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020), edited (Anika Albrecht, LfULG)

7.5 Land use and forests



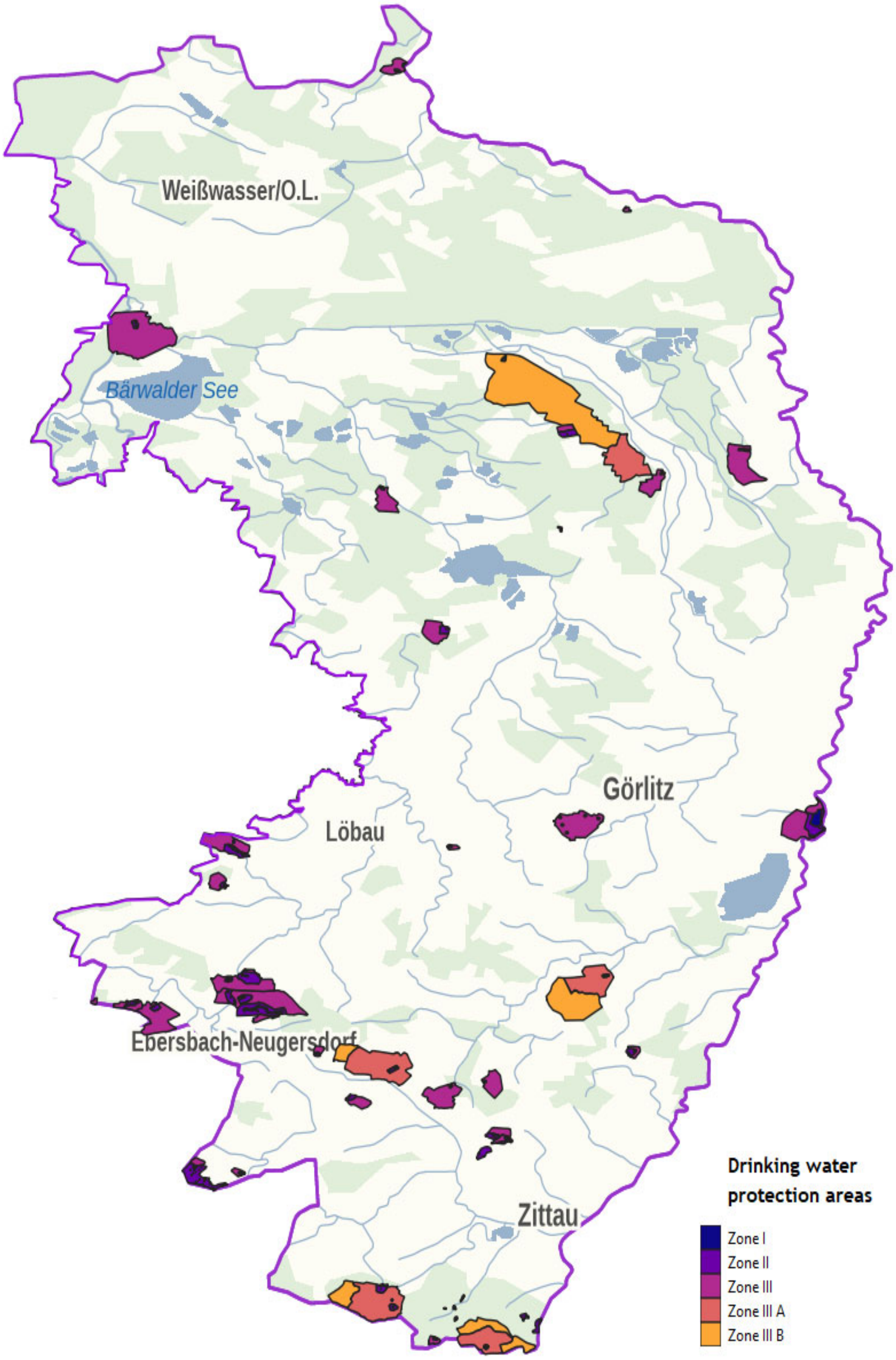
Source: Internationales Begegnungszentrum St. Marienthal and Leibniz-Institut für ökologische Raumentwicklung (Ed.): Nachhaltige Nutzung von Energiepflanzen für eine regionale Entwicklung im Landkreis Görlitz. Data base by LfULG, edited.
http://www.nachhaltiges-landmanagement.de/uploads/tx_t3documents/00100-Lupp_et_al_Handlungsleitfaden_L%C3%96BESTEIN_2013.pdf

7.6 Protected areas



Source: Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020), edited (Anika Albrecht, LfULG)

7.7 Drinking water protection



Source: Staatsbetrieb Geobasisinformation und Vermessung Sachsen (2020), edited(Anika Albrecht, LfULG)

7.8. Integration of heavy rainfall prevention into municipal planning - guide for municipalities in the district of Görlitz (short version)

In the past months and years, heavy rain events have caused great damage, including in the district of Görlitz. They can hit any place with only a very short warning time. Heavy rain events are often short and locally limited precipitation events. Uncontrolled surface water runoff up to flash floods can occur (BMBF 2008). Prevention and protection against heavy rainfall events and flash floods are a communal task and must be integrated into planning at an early stage.

In the Pilot Action 2 stakeholders from the City of Zittau and the district administration of Görlitz tested the TEACHER-CE Toolbox by identifying the observed and expected climate changes, by defining the corresponding prominent challenges (issues), by identifying measures and by comparing the results with the results of the Toolbox CC-ARP-CE. Furthermore, the orientation guide "Involving heavy rain risk prevention in municipal planning" was developed, which is addressed at the municipalities of the district of Görlitz. Its aim is to demonstrate the possibilities for heavy rain risk prevention in the field of spatial planning and thus to reduce the risks of flooding caused by heavy rain. This supports sustainable development in the municipalities, as the measures within the settlement areas have numerous synergies with other water management and urban development objectives.

Which climate changes can already be observed? Which are to be expected in the future?

For the district of Görlitz, an increase in mean air temperatures of 1 Kelvin could already be determined for the period 1991-2019 in relation to the reference period 1961-1990. In addition, summer and hot days have become more frequent. In the future, among others, a further increase in the average annual temperature is expected. An increase in heavy rain events, especially in summer, is also expected due to a change in major weather patterns and the overall significant increase in temperatures. (LfULG, TU Dresden, ReKIS 2021a, 2021b, LfULG 2021)

The most important challenges for urban development arising from the climate changes mentioned above include the increasing health burden on residents due to the increase in heat and dry periods, as well as damage to buildings and infrastructure due to increased precipitation in winter and heavy rain events.

Which strategic principles and measures contribute to heavy rain risk prevention in municipal planning?

In order to counteract the risks of heavy rain in a precautionary manner, the instruments of spatial planning can be valuable tools to enable the implementation of concrete measures. In this respect, potential measures are intended to show what options spatial planners have in the context of heavy rain risk management. In general, potential measures can be assigned to the following objectives: prevention, relocation, safe discharge, communicating risks (WM BW 2018, DWA 2016).

For local authorities, successful heavy rain risk management starts with the identification, assessment and mapping of potential heavy rain hazards and risks. Mapping of heavy rain hazards and risks also helps in communicating the issue and activating citizens to take precautions themselves. A variety of methods are available for identifying the hazards of heavy rainfall, which can be divided into the groups of empirical methods, flow path analyses and hydrodynamic simulations. Based on the identification and presentation of hazards from heavy rain, the risks can be assessed.

Like other current challenges, heavy rain prevention is a cross-sectional task for which an overall concept is needed. This concept defines overall goals for the respective municipality and thus provides the basis for the coordination of tasks between different departments and authorities. Such an overall concept for dealing with too much and too little water in settlement areas should follow the guiding principle of "water-sensitive urban development". It pursues the goal of ensuring the sustainable use of available water resources. The focus is on local infiltration, evaporation, utilisation, storage, and curbed discharge of water masses. The development of an overall concept requires the cooperation of the municipal drainage management with other actors.

Which planning options are possible for the reduction of heavy rain risks?

Especially impacts caused by heavy rain events should be adequately considered in urban land use planning and municipal construction projects (LAWA 2018). In this context, measures and concerns from different disciplines must be spatially coordinated. At the local level, urban land use planning is the most important instrument in Germany for regulating land use in the municipality. Urban land use planning consists of the land use plan and the urban building plan. According to the German Federal Building Code, urban land use planning must explicitly take into account flood protection and flood prevention, thus avoiding and reducing flood damage. Measures to adapt to climate change are also to be considered in the development of urban land use plans.

By drawing up the land use plan, the municipality regulates urban development and determines the building use of the land in the municipality. Precautionary measures to reduce the impact of heavy rain events can also be anchored in the land use plan, for example, open spaces can be created or preserved. The various options for the representation of heavy rain precautions in the land use plan are laid down in the Building Code.

Municipalities have a wide range of options for defining flood protection measures in urban building plans and can thus anchor important elements of flood protection in a legally binding manner. At this level, for example, the type and extent of building use can be specified to reduce the risk of heavy rain (Sustainability Center Bremen o.J.). Important aspects to be examined when drawing up the urban building plan include the location and course of former watercourses and natural floodplains (DWA 2013). The measures that can be defined in urban building plans are laid down in the Building Code.

Further legal framework conditions are formed by statutes with local building regulations of the municipalities, which are established in accordance with the respective valid state building regulations. Informal planning instruments such as urban planning competitions can be linked to formal planning.

Which obstacles are encountered during implementation? Which solutions are possible?

Integrated action in the planning process is often made difficult by administrative structures. If rainwater management is considered (too) late in the planning process, the possibilities for water-sensitive urban development are reduced. A targeted optimisation of structures within the administration as well as the early integration of decentralised rainwater management into the planning process can contribute to a better use of the potentials for water-sensitive urban development.

As described, climate change not only increases the risk of heavy rain events, but also other climate-related risks. Measures such as unsealed areas and green structures not only reduce the risk of flooding due to heavy rain, but also the heat load in the immediate vicinity. However, if these green structures are not sufficiently supplied with water, they also have no cooling effect. Decentralised nature-close solutions for improving the water balance, such as decentralised infiltration of rainwater, can contribute to reducing the costs of sufficient irrigation of green spaces.

Finally, a lack of willingness to participate/interest on the part of private owners is often observed. There are many reasons for this, including scepticism towards decentralised rainwater management systems. Targeted communication and public relations work with information materials or other forms of participation can support a change in thinking.

7.9. Synergies of adaptation measures through water sensitive urban design - Focus area of Martin-Wehnert-Platz in Zittau (short version)

In the past months and years, climate change effects became noticeable in the City of Zittau as well as in the rest of the County of Görlitz. In the Pilot Action 2 stakeholders from the City and the district administration tested the TEACHER-CE Toolbox by identifying the observed and expected climate changes, by defining the corresponding prominent challenges (issues), by identifying measures and by comparing the results with the results of the Toolbox CC-ARP-CE. Furthermore, the identified measures implemented in a study area were modelled to analyse their effects and to give feedback to the catalogue of measures in the Toolbox.

Which climate changes can already be observed? Which are to be expected in the future?

For the district of Görlitz, an increase in mean air temperatures of 1 Kelvin could already be determined for the period 1991-2019 in relation to the reference period 1961-1990. In addition, summer and hot days have become more frequent. In the future, among others, a further increase in the average annual temperature is expected. An increase in heavy rain events, especially in summer, is also expected due to a change in major weather patterns and the overall significant increase in temperatures. (LfULG, TU Dresden, ReKIS 2021a, 2021b, LfULG 2021)

Which challenges (issues) were identified for the City of Zittau?

The most important challenges for urban development arising from the climate changes mentioned above include the increasing health burden on residents due to the increase in heat and dry periods, as well as damage to buildings and infrastructure due to increased precipitation in winter and heavy rain events. These were entered into the part “Identification of issues” into the Toolbox.

Which adaptation measures could be implemented?

The measures identified by the Toolbox CC-ARP-CE are the following:

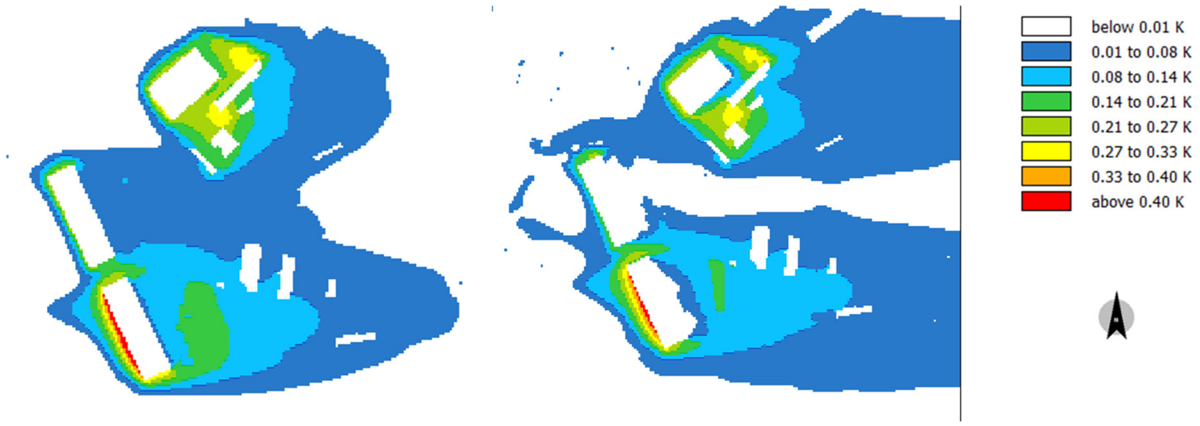
- Green roofs and green facades
- Multi-functional traffic and parking areas (ensure/increase runoff capacity and temporary retention)
- Preparedness for flood events in public and private buildings
- Infiltrating pavements/permeable surfaces; unsealing
- Sealing of buildings in the underground
- Flood risk adapted (water resistant) buildings

In close cooperation with the City of Zittau, a study area was identified in which the implementation of the measures was simulated. The study area covers an area of approx. 21 ha around Martin-Wehnert Platz, south of the historic city centre. The starting point is a mobile home park and green open spaces at Martin-Wehnert Platz, which are to serve as the site of the new rescue station and THW building. A total of three buildings of different dimensions are planned. This is accompanied by additional surface sealing, which increases the vulnerability described. Hence, the above-mentioned measures are being modelled in two different scenarios that improve the resilience of the new buildings. Only the measures “Sealing of buildings in the underground” and “Preparedness for flood events in public and private buildings” cannot be simulated as the model cannot display measures underground or preparedness respectively. The motivation is to see to what extent water-sensitive measures have a synergetic effect on the urban climate.

Which conclusions can be drawn for the implementation of the measures?

The results clearly demonstrate the effectiveness of the adaptation measures, but the extent of cooling that can be reached by the measures' implementation is little.

The figure below shows the differences between the construction of the buildings without any specific adaptation measures and the construction of the buildings with the above-mentioned adaptation measures. On the map displaying the implemented adaptation measures, it can be seen that on the eastern side of the buildings, on the leeward side, and between the buildings on the northern edge, the temperature increase is less than on the map without the measures. Also, the trees that were simulated around the unsealed parking space, cause a reduction in ventilation in this case.



Temperature changes, when the buildings are built without adaptation measures

Temperature changes, when the buildings are built with the mentioned adaptation measures

Comparing the different results, the following effects became visible:

- Intensive green roofs have a significantly greater effect than extensive green roofs.
- Unsealing: water-bound pavement rather than grass pavers for car park
- Trees / tree corrals cause a reduction of wind speed but a quality of stay on hot summer days

The shadow cast by the trees, which selectively improves the quality of stay, is to be discussed further within the City administration. In addition, green roofs and façades have a demonstrably positive effect on the indoor climate, which cannot be considered here, but gives an additional argument in favour of implementing measures with regard to temperature stress.

The effects are relatively low, as in the study area many open spaces and green areas already allow air exchange and there is hardly any climatological potential for improvement through additional vegetation and drainage. However, in view of strong extreme weather events in the region, an adaptation makes a lot of sense from a hydrological point of view.

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