



Climate Policy Programme Bavaria 2050



Climate Policy Programme Bavaria 2050

Foreword	3
----------------	---

Mitigation of Climate Change as an International Model

Energy Conservation and Energy Efficiency	5
Expansion of Renewable Energy	7
Funding Priority: Local Climate Protection	9
Moor Conservation in Bavaria	10
Bavarian Climate Alliance	12

Regional Adaptation to the Consequences of Climate Change

Climate Proofing Bavaria Programme	14
Geohazards	21

Research and Development

Bavarian Climate Research Network	23
Schneefernerhaus Environmental Research Station	23
Bavarian Climate Report 2050	24
Sector-specific Research	25

Foreword

Climate change has been present in Bavaria for a long time – it is both noticeable and measurable. The average temperature here rose by ca. 1.1°C between 1931 and 2010, and in the sensitive Alpine region, temperatures have risen even twice as steeply as the global average over the last 100 years. Bavaria cannot escape the inevitable effects of climate change; in the future we are expecting more extreme weather events, wetter winters and drier summers. The effects of these developments are also reflected in the communities in Bavaria and have an impact on people's lives.

Bavaria is facing up to its responsibility for the climate. Since 2008, we have invested around one billion euros in climate protection. With around 6 tonnes of energy-related CO₂ emissions per person per year, Bavaria is ranked alongside the most advanced industrialised nations in the world (compared to the national average of ca. 9 tonnes of CO₂ per capita per annum or 16 tonnes in the US).

Nevertheless, we still want to do more for climate protection, which is why in 2014 we enacted the Bavarian Climate Policy Programme 2050. From upgrading the energy performance in state and municipal buildings to the restoration of moors through to energy technology projects, an array of measures now complements our proven three-pronged strategy of reduction, adaptation and research. It is our firm intention to reduce greenhouse gas emissions in Bavaria to fewer than 2 tonnes per person per year by 2050 – a goal that is as just as it is ambitious! Moreover, we will be promoting climate adaptation in our efforts to make Bavaria climate proof; for example, by providing a total of 3.4 billion euros for flood protection. In addition, we will also be furthering climate research because knowledge is the indispensable foundation for successful strategies.

This brochure provides an overview of the current Bavarian climate policy measures.



Horst Seehofer
CSU Chairman
Bavarian Minister-President



Ulrike Scharf MdL
Bavarian State Minister of the
Environment and Consumer Protection

Mitigation of Climate Change as an International Model



Energy Conservation and Efficiency

Around three-quarters of German greenhouse gas emissions are energy related. Consequently, the conversion, transmission and use of energy are key areas of activity in climate protection. At the same time, providing climate-friendly energy involves using energy resources sparingly, which also helps to curb import dependency.

The building sector is responsible for about 40% of the total energy consumption and 30% of the CO₂ emissions in Bavaria, of which the vast majority arises, in turn, from the demand for heating and warm water.

Energy standard in public building work

The Free State of Bavaria leads by example. The construction of new administrative buildings is generally carried out in accordance with the passive house standard. A number of new construction measures have been used for selected special structures (e.g. museums), in coordination with the responsible departments, as pilot projects of the passive house standard; these measures are then scientifically evaluated. All other measures for new and existing buildings are at least 30% lower than the legal standard requirements.

Upgrading the energy performance of state and municipal buildings

By means of a special programme that started in 2008, more than 200 million has been put towards upgrade the energy performance of state buildings, which constitutes an essential part of the Climate Protection Programme. The aim is to save the maximum amount of CO₂ given the resources available. Furthermore, since 2014, energy monitoring devices have been installed and the Central Energy Management System has been implemented. To date,



Above:
Upgrading the energy performance of the University of Applied Sciences in Landshut as part of a special programme to upgrade state buildings in 2013.

Page 4:
Extension of the Bavarian State Parliament in accordance with the passive house standard.

it has been possible to achieve considerable energy savings in state buildings – more than 12 million per year. The associated reduction in CO₂ adds up to more than 1.2 million tonnes of CO₂ (absolute).

A further 20 million euros have again been made available for the 2015 special programme. The basic conditions correspond to the specifications of the 2014 special programme. Due to the co-funding commitment in the ERDF Programme (European Regional Development Fund), it is not currently possible to outline the exact scope of the funding for the 2015 special programme et seq. As the current state of implementation stands, 22 measures have been authorised, resulting in savings of more than 14,000 tonnes of CO₂.

Observing the legal requirements for energy efficiency also provides a significant contribution to climate protection in the redistribution of municipal funding for building construction projects (schools, day care facilities), simultaneously easing the burden on our environment.

Use of renewable energy in state building construction

The use of renewable energy in all state building construction projects is continually assessed. The following installations are currently incorporated or planned in state properties: 130 buildings with solar thermal facilities and a collector surface area of approximately 5,200 m²; 187 buildings with photovoltaic systems, a surface area of approximately 17,444 m² and a peak output of almost 1,999 kilowatts; 94 buildings with biomass heating systems and an output of over 9,000 kw; 35 buildings with CHP systems and an approximate output of 31,000 kw of thermal energy or

Right:
Bavarian housing
construction pro-
gramme: Plus
Energy Standard
housing complex,
Kruener Strasse,
Munich.



Below:
The 10,000 Houses
Programme
promotes energy
measures for private
homeowners.

16,000 kw of electricity; and 8 buildings using geothermal energy systems with an output of approximately 2,000 kw. Examples of energy efficient buildings and systems technology can also be found in the energy reports published regularly by the Bavarian State Property Administration (Bayerischen Staatlichen Hochbauverwaltung).

Supply of green electricity for state properties

It is now a requirement for all central invitations to tender for state authorities that all of electricity supplied must be produced from renewable energy. Since 2014, all corresponding property belonging to Bavaria has been supplied with electrical energy that meets these requirements. This constitutes approximately 1% of the electricity used in the Free State of Bavaria.

10,000 Houses Programme

The Bavarian government's 10,000 Houses Programme will run from September 2015. The aim of this new subsidy programme is to support citizens who invest in innovative solutions for the generation, storage and intelligent management of energy in their homes. Focusing on the modernisation of detached and

semi-detached houses, the programme will be an effective contribution to the improvement of energy efficiency in existing buildings and to the reduction of CO₂ emissions. 90 million will be made available for this programme between 2015 and 2018 via The Bavarian State Ministry of Economic Affairs.

Climate protection through the use of wood

As they grow, trees extract carbon dioxide from the atmosphere and absorb carbon into the wood. Forests and wood products are therefore great natural stores of CO₂ whose effect on climate protection can be further enhanced by the intelligent material use of wood in particular fields of application.

The findings of the latest national forest inventory show that Bavaria is the number one state in Germany for forests and wood. Every third cubic metre of wood is in Bavaria's forests, amounting to a total of one billion cubic metres. A further cubic metre grows every second. At the same time, every year for the last few decades, less wood has been cut down on average in Bavaria's forests than has grown back. Nevertheless, in private forests in particular there is still a lot of potential for even more trees.



Scientific studies by The Technical University of Munich have revealed that by using just a third of the annual sustainable amount of useable wood, all new constructions in Germany could be built from timber. This would avoid having to use a huge quantity of far more energy-intensive building materials (substitution effect). Building with wood from sustainably managed domestic forests is therefore a particularly efficient method of preventing CO₂ emissions.



Expansion of Renewable Energy

Due to the considerable efforts of the last few years, Bavaria occupies the top position nationwide for the generation of electricity from renewable energy. In 2013, 31.6 TWh of electricity came from sustainable energy.

The Free State of Bavaria is therefore well on the way to converting its electricity supply into a connected system based largely on renewable energy, producing the minimum possible CO₂ emissions, thereby further advancing climate protection.

As a result, we are establishing flagship and reference projects displaying exemplary wood use for new build as well as for renovation work on state buildings. Innovative wood products made from climate-tolerant (deciduous) tree species should be used as far as possible, since additional added value for deciduous wood leads to a higher appreciation for deciduous trees and, thereby, more mixed woodland. Innovative wood products also open up new prospects for enterprises that up to now have predominantly processed spruce and other coniferous wood.

Besides the additional investment for using wood, this measure resultantly also forms a basis for communication: With the exemplary buildings we intend to actively reach and motivate opinion formers, technical planners and decision makers, as well as forest owners and consumers (potential house builders, homeowners).

Water

Due to its topography, Bavaria is a traditional hydropower state. In 2013, the electricity generated by the ca. 4,000 hydropower plants in Bavaria amounted to 13.1 TWh. Consequently, CO₂-free hydropower continues to be the chief renewable energy source in Bavaria and a mainstay of the electricity supply. Despite fluctuations caused by water flow, hydropower provides a significant contribution to ensuring a secure supply as well as to grid stability. With regard to the potential for further expansion, it is of prime importance to implement all initiatives that either do not or only minimally affect river ecology, e.g. through modernisation (replacement of turbines and generators) and upgrades (e.g. the installation of additional turbines or increasing reservoir levels). New constructions should primarily be erected at existing transverse structures or incorporated sustainably as part of essential river restoration.

Above:
From research and development to exemplary application: The Free State of Bavaria is committed to innovative wooden building materials from climate-tolerant tree species. This picture shows glued laminated beechwood in the new "Steigerwald Centre – Experience Sustainability" in Handthal.



Below:
Hydroelectric power station on the Lech river.

Wood chips: renewable fuel for thermal power stations.



Photovoltaics

With its high number of sunshine hours, amounting to between 1,400 and 1,700 per year, Bavaria leads Germany in its use of photovoltaics (PV). Construction of photovoltaics in Bavaria has experienced a sharp increase in recent years and is now the second most important source of energy after hydropower in the generation of electricity. In 2013, 9 TWh of electricity was generated from approx. 460,000 photovoltaic systems. This increase mainly happened on roofs in a manner compatible with the landscape and the environment as well as in open space constructions – primarily along motorways, railway lines and on redevelopment sites. As photovoltaic systems can also be operated on small areas and with minimal investment, solar energy is the most common renewable energy among domestic users.

Bioenergy

Bioenergy is an important source of renewable and climate neutral energy in Bavaria. It is a very versatile energy source that can supply the demand for electricity, heat and fuel in solid or liquid form, or as gas.

In 2013, 7.8 TWh of electricity was generated from bioenergy. At the same time, it represents the most significant source of renewable energy for the supply of heat. One big advantage of bioenergy is that it can be stored temporarily and saved in large quantities. In accordance with the Bavarian “Flexible use of biogas to generate electricity” plan, flexible and needs-based run biomass systems can provide a more substantial contribution to supply security in the future. There is further potential for expansion, for example through the climate-friendly use of residual and waste

materials, from manure and also by using wood gasification plants to convert wood into electricity.

The new “RapsTrak200” funding programme encourages the use of rapeseed and plant oil fuels in modern agricultural and forestry tractors and non-road mobile machinery, thereby driving forward the launch of this climate-friendly technology.

Wind

Good progress is being made in the drive to use more wind energy in Bavaria, with the amount of electricity produced rising to 1.3 TWh by the end of 2013. The performance and energy yield of new wind turbines has improved significantly over time. An all-time high was actually recorded in 2014 when 154 new wind turbines were erected with an output of 410 MW. This means that at the end of 2014, there were a total of 797 installations on the grid in Bavaria, with a cumulative output of around 1,500 MW. These expansion figures are impressive given that Bavaria is an inland area with low wind. The wind energy directive, which contains detailed instructions on the planning and approval for wind power stations is currently being updated. The aim is to be able to conduct the necessary approval process swiftly and uniformly. The new edition of the Bavarian wind atlas, which provides a summary of wind patterns across the whole of Bavaria and indicates the prospects of wind energy use with wind speed and energy yield maps, was published in May 2014.

Meanwhile, six so-called wind support bases (WSB) have been erected across Bavaria, providing information on different subject matters. WSBs can play an important role in



Funding Priority: Local Climate Protection

the sustainable development of wind power by increasing the acceptance of wind power and encouraging collaboration between communities, energy suppliers, the wind industry and researchers. Bavaria is sponsoring each WSB with up to €150,000.

Geothermal energy

Geothermal energy (terrestrial heat) is divided into near-surface (up to approx. 400 m deep) and deep (exploitable up to approx. 7,000 m deep) geothermal energy. The conditions for such exploitation of terrestrial heat in Bavaria are favourable in many places because it is available irrespective of weather and time of day. In addition, when properly designed, it is a resource and climate-friendly energy source that can be used mainly as a local and district supply for heating buildings as well as partly for generating electricity. In the long term, deep geothermal energy offers great potential for the heating sector with high regional significance, particularly in South Bavaria. However, until 2021, it is set to only provide a small contribution towards the electricity supply of between 0.3 and 0.4 TWh. By comparison, the amount in 2013 was 0.05 TWh.

In order to tap further potential, fields and reservoirs must be more extensively used and connected in the future. At the same time, there is a great need for more research. Among other sources, funding for research and development within the scope of the Bavarian Geothermal Alliance (TU Munich, FAU Erlangen-Nuremberg) will provide a total of € 11 million from 2015 on. What's more, further development will be supported by grants from the "Programme for the increased expansion of deep geothermal energy heating grids", which has been extended until the end of 2018.

The Free State of Bavaria supports Bavarian communities and other bodies by carrying out measures aimed at reducing the CO₂ emissions of their properties, thereby achieving a significant contribution to climate protection through energy conservation.

Planning measures are supported and, in certain justified cases, even their implementation as well as participation in quality management and certification processes for the public energy sector. Funding guidelines have been expanded and now take into account the implementation of more ambitious energy standards for public property, such as the passive house standard for new constructions or the 3-litre-house standard for renovations.

Support with strategies, planning and consultancy, as well as the necessary involvement and participation of communities in the rural districts and villages, is provided by the rural development offices in preparing and assisting rural development projects. An additional funding bonus in the scope of village renewal may be granted for extraordinary expenditure on energy saving measures. Furthermore, creating small public or communal facilities for the environmentally or climate-friendly supply of energy is also supported financially.

Deep geothermal energy: drilling site in Aschheim near Munich.

Moor Conservation

Naturally, there are high water levels in wetlands. As a result, dying plant parts do not decompose, as the fungi and bacteria that normally cause this process need oxygen from the air. Consequently, peat is formed, whereby wet plant materials accumulate – sometimes over thousands of years. If a moor is drained, the aired peat begins to decompose and the carbon contained in it is released in the form of carbon dioxide (CO₂) and other gases that are harmful to the environment, such as methane and nitrous oxide. According to a study by The Weihenstephan-Triesdorf University of Applied Sciences, through the restoration of upland moors, fens and half-bogs, which extend over more than 220,000 hectares in Bavaria, emissions of climate-relevant gases could be reduced by approx. 5 million tonnes of CO₂e per year.

Moor restoration

In light of climate change, the reduction of emissions from drained bog soils is a special task for the state and society. Since 2008, 19 moorland areas – each over 10 hectares in size – and a further six smaller moors have been completely restored as part of the state government's climate programme. In a further 50 moorland areas, smaller scale rewetting and other measures have been carried out. In total, more than €13 million has been invested. Conservation funding for the restoration of moorland will also be allocated in the new Bavarian Climate Protection Programme 2050.

As part of the pilot project, measures in certain districts are now also receiving subsidies from the European fund for regional development. €12 million is available for this 50% co-financing deal. Further subsidies are offered by the Bavarian conservation fund, or they will be raised by the federal government through major conservation projects, such as the Chance Natur "Allgaeuer Moor Alliance" project. In addition, climate protection certificates will be further developed – so-called "moor benefits" – which can be purchased by businesses to compensate for climate gas emissions and which directly benefit the Bavarian moors.

Moor conservation in forests

In state-owned forests, as many upland moors as possible should remain permanently in a favourable state of conservation or be appropriately restored. This is because the issues of conservation and the protection of the climate, water and soil are of particular importance there, which also means there are comparatively few conflicts of interest. Projects with a particularly good benefit, feasibility and cost ratio have priority here.

Restoration measures have been carried out with varying intensity in all of the significant moorland areas in state-owned forests since the beginning of the 1990s. At a conservative estimate, more than 100 measures have been implemented in over 50 moorland areas. After successful completion of current research projects, the restoration work on upland moors is set to be accelerated. For moor areas with medium to high priority, the measures should

The restoration of upland moors in state-owned forests sometimes requires machines to stop drainage, such as here in Haspelmoos.





The “people factor” (landowner, specialists, authorities, neighbours, stakeholders, media etc.) plays a decisive role in the success of moorland restoration in forests.

be widely implemented across at least 30% of the area by 2020 and across the entire area by 2030, assuming third party interests or conflicts of interest allow. Among others, the Bavarian forest authorities (Bayerischen Staatsforsten and Bayerische Forstverwaltung) and Forestry are placing particular emphasis on this with the so-called “Special general interest service in the state forest” project.

Preservation of moors used for agriculture

As part of the new Bavarian cultural landscape programme, there is an opportunity to receive higher funding for the conversion of arable land to grassland on moor sites for the 2015-2019 commitment period. There is also the possibility to combine this with extensive utilisation.

Soil management for moor conservation

To achieve the aim of protecting moors, targeted soil management for rural development will also be introduced. Where the fragmentation of land ownership prevents the appropriate coordinated development of an area, the conditions for the sustainable protection, preservation and, if necessary, optimisation of the land required for conservation can be provided for by certain land purchases and land swaps. The areas where the most sustainable effects can be achieved will be mobilised and made available, where possible. In many projects, such as Murnauer Moos, Kulzer Moos, Forstmoos, Kematsrieder Moos, the Dattenhauser Ried or Ruselmooren, the primary goals of climate protection through the preservation of grasslands and fens have and will continue to be pursued with the aid of land readjustment.

Biological CO₂ storage in water meadows

Water meadow regions offer a multitude of functions and services, meaning they can be classified as particularly significant ecosystems. Apart from their function as natural flood plains and retainers of nutrients, and the high quality habitat they provide for plants and animals, water meadows can also make a significant contribution to the absorption of climate-relevant greenhouse gases, including carbon dioxide.

This function will be strengthened by the restoration and reconnection of former water meadow regions to bodies of water. As part of the 2020plus Bavarian flood protection action programme, in addition to technical flood protection, an attempt will also be made to improve natural retention in bodies of water and water meadows, for example, through dyke relocation or reconnecting dry water meadow sites to water. Such projects, in addition to the water restoration work that will be implemented under the EC Water Framework Directive, can serve to increase the number of viable water meadows in Bavaria and thus boost CO₂ storage at the same time. Exemplary projects of this kind are the “Isar Plan Munich” restoration, the “Wertach vital” restoration in Augsburg, the restoration of the Vils in Lower Bavaria and the revitalisation of the Danube flood plain between Neuburg an der Donau and Ingolstadt.



Revitalisation of the Danube flood plain – ecological flooding.

Bavarian Climate Alliance

Climate protection means reducing greenhouse gas emissions and adapting ourselves intelligently to the effects of climate change. This applies to all areas of our society, from the energy sector to trade and industry, agriculture and forestry management and traffic, right the way through to private households. As climate protection is a cross-sector task that applies to us all, the Bavarian government, together with the Bund Naturschutz in Bayern (Bavarian Nature Conservation Association), started the Bavarian Climate Alliance in 2004 to bring together the many societal stakeholders. The partners support each other with measures for sustainable climate protection and for adapting to climate change. They impart knowledge, involving as many sectors of society as possible, and thereby motivating them to act in a climate-friendly manner.

The Bavarian Climate Alliance has developed successfully since its foundation: With more than 30 partners from environmental and community associations, churches, youth work, education, the economy and science, the Climate Alliance reaches and represents a significant proportion of the Bavarian population. Partners of the Bavarian Climate Alliance see themselves as disseminators of the idea of climate protection. They act on the basis of shared values and beliefs, which is their recipe for success. One core common effort in this is the Bavarian Climate Week, which has been run annually since 2008 with a variety of events. It helps the Bavarian Climate Alliance to spread the concepts of climate protection more widely and intensively in society.

On 9 October 2014, the Bavarian Climate Alliance celebrated its 10th anniversary at a state reception. The Bavarian government and the partners of the Climate Alliance introduced a new charter on climate protection.



Regional Adaptation to the Consequences of Climate Change



Climate Proofing Bavaria Programme

Forestry

Forest restructuring

Forests, and with them the approximately 700,000 forest owners in Bavaria, rank among those most affected by climate change. There is particular need for adaptation in spruce forests as well as in spruce and pine forests in the warmer regions, such as in Central Franconia or the tertiary hill country. Action is required on around 260,000 hectares of private and corporate forest alone.

To begin with, it is planned to turn 100,000 hectares of severely endangered private and corporate coniferous forests into climate-tolerant mixed forests by 2020. This ambitious goal can only be achieved collectively with the private and corporate forest owners, as success and progress in forest restructuring is dependent on the independent decisions of the owners. The management and maintenance of all forests, particularly the small private forests, must be ensured, especially with regard to climate protection and energy transition. Persuasive efforts are needed here to build trust, have a customer focus, set good examples and maintain a long-term approach. Forest owners who actively manage their forest are generally organised in forestry associations. These particularly important partners to forest restructuring will be supported by the Free State of Bavaria with advice and funding.

Between 2008 and the end of 2014, over 42,000 hectares of locally adapted mixed forest were newly created in private and corporate forests. Forest restructuring in corporate forests serves as a role model that also radiates to neighbouring private owners. The silvicultural funding programme was made more attractive in 2014 in order to contribute more effectively to the ambitious forest restructuring targets. Funding for forestry associations has now also been enhanced to focus on structural improvements, particularly in fragmented small private forests. A new Internet forest-owner portal, which has a “forester finder”, was introduced at the beginning of 2015 to extend the communications and advisory service for all urban forest owners to the web 2.0 generation. Annual local forest-owner days, which are held in the various regions, offer a great platform for tens of thousands of forest owners and citizens to talk and network.

In conjunction with the advisory and training services offered by forestry management, the new silvicultural funding programme, with an increased funding rate for regeneration measures by ca. 20%, creates an incentive for forest owners to start regeneration in a timely manner with the advance planting of mixed tree species. The previous forest regeneration projects are now also being enhanced and implemented throughout Bavaria.

The early introduction of climate-tolerant coniferous trees stabilises pure coniferous populations, such as here in Obermainhuegelland, making them more resistant to climate change.



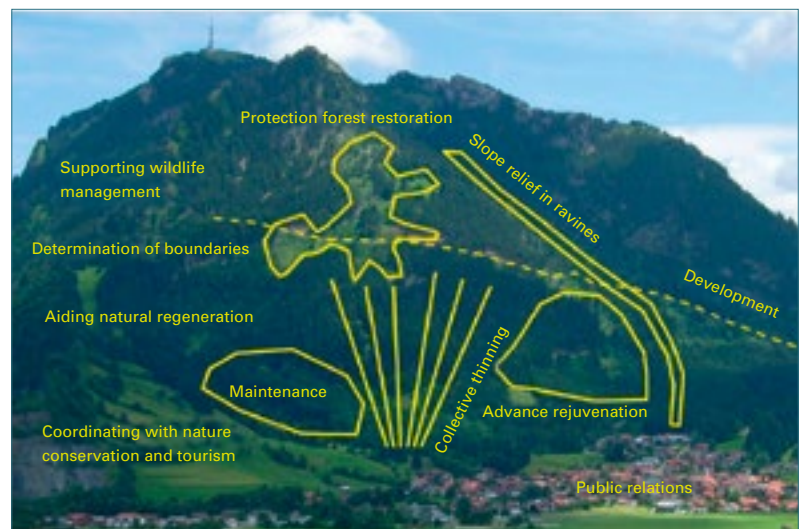
Mountain forest campaign

Our mountain forests are a unique natural treasure. They offer recreation and the chance to enjoy nature, are the habitat for many endangered species and, at the same time, enable the use of wood – a renewable resource. They also provide an important contribution to effective, economic and natural protection against natural hazards.

In the Alpine region, much higher temperature increases are expected as part of climate change than in the lowlands. This particularly threatens the effectiveness of mountain forests to protect the inhabitants and their material assets, both in the mountains and in the Alpine foothills. With rising temperatures, growth conditions also change for the mountain forests. Pest infestation, e.g. by bark beetles, becomes more common. Above all, this affects the dominant tree species in our mountain forests: the spruce. As a consequence, the forests in the Alpine region must be prepared for climate change in a timely manner. The adaptation of the mountain forests demands expert care and the rejuvenation of the forest itself. It also desperately needs continuous redevelopment of the barrier woodland and the participation and support of all local stakeholders.

Within the scope of the Mountain Forest Campaign (BWO), measures for the stabilisation and sustainable adaptation of mountain forests to climate change will be intensified and implemented in accordance with the aims of the Alpine Convention in especially designated project areas. The important factors for success in the 45 current project areas have predominantly proved to be the concentration

of activities on project areas, the support of project managers and the comprehensive involvement of forest owners and stakeholders (hunters, conservationists, municipalities etc.), in project-related BWO advisory councils. The future focus – building on improved development – will mainly be on implementing silvicultural maintenance and regeneration measures.



East Bavarian Forest Initiative

In Northeast Bavaria, many trees have been weakened by previous pollutants and nutrient-poor soils. They are therefore particularly vulnerable to the effects of climate change. This effect will be considerably intensified by the past use of unsuitable seed and planting materials for spruce. In order to step up the development of climate-tolerant mixed forests in private and corporate forest, and to improve their protective role, the Bavarian Forest Administration started the “East Bavarian Forest Initiative” – along the lines of the mountain forest campaign – in July 2013. One main focus is the introduction of fir trees.

BWO projects include a wide range of activities in large areas, e.g. on the Gruenten in Allgaeu.

In extensive alluvial forests, flood water will be held back and outflow will be curbed.



Water management

Climate change affects all areas of water management, for if the climate changes, this also influences regional water supplies and water quality. The result is heavy rain and floods as well as drought, low water levels and higher water temperatures. Water is the uniting factor that directly or indirectly connects nearly all areas of public life. For this reason, integral adaptation measures for water management are required in the following areas of activity:

Groundwork, monitoring and warning services

The KLIWA (Climate Change and Consequences for Water Management) project is increasingly focusing its activities on the development and advancement of recommendations for action. Monitoring climate change-related shifts in water balances is an important basis for the operation of predictive models and warning services. To enable prompt reactions to drought or low water situations, the existing low water information service (www.nid.bayern.de) will be continued and further developed. At the same time, both the flood information service and the flood risk areas information service will continue to be run and will be updated continuously.

Flood protection – amendments to the 2020 Flood Protection Action Programme

All forecasts indicate that climate change will also affect flow extremes with floods. Floods threaten human lives, private and business assets, as well as “critical” infrastructure, such as the electricity supply. It also triggers further indirect costs, e.g. in the form of production losses, or the deployment of emergency or disaster relief services. Flood protection is part of public service and represents crucial security

infrastructure. However, there is no absolute protection against flood risk – something that was made abundantly clear by the major floods of 1999, 2005 and 2013 in the Danube region. Flooding is a natural phenomenon that cannot be stopped. As a result, suitable strategies are required for dealing with the risk of floods that also take into account shifts due to climate change.

Concept 2020plus: in all areas of flood risk management, improvements and further development are planned as part of the 2020plus Action Programme (AP). Selected examples include further improving information and warning services as well as flood forecasting, stepping up risk dialogue together with implementing flood risk management guidelines, and determining flood areas on other stretches of river. In the future ca. €150 million per year will be available for implementing the so-called 2020plus AP, in place of the current €115 million. In addition, the special Danube Flood Protection Programme has been passed with a budget of €600 million. This increases the funding for flood protection in Bavaria for the 2020 and 2020plus APs from €2.3 billion to €3.4 billion. This funding includes all measures to be implemented on state-owned bodies of water, reservoirs and torrents. With the 2020plus AP, Bavaria has also set the right course with regard to climate change and will continue to invest heavily.



Left:
2013 floodwaters
at Weidachwiesen
polder.



Right:
Avalanche nets
in winter.

Retention and resilience

One major innovation is the so-called “extended retention approach”. This Bavarian-wide master plan includes the systematic survey of potential for retention in the various flood areas, the analysis of their effects and the intensified implementation of suitable measures. The most significant sub-elements are:

- “technical retention” with the implementation of the Bavarian flood polder programme;
- “natural retention” with dyke relocation and reconnection of water meadows; and
- other measures, such as the optimised control of existing reservoirs or the increased use of water meadows as a contribution to flood retention.

Resilience means that the systems do not fail completely even when overloaded but can at least mitigate disasters.

Torrents and avalanches

The threat of torrents and avalanches is mainly an issue in mountainous regions. This is predominantly the effect of the rugged terrain and increasingly extreme weather conditions. Possible effects of climate change with regard to, for example, torrent risks (as with flooding) are not only an increased likelihood of their occurrence but also an increased intensity of the individual events themselves. Thus, extreme events could occur more frequently in the future, or once every 100 years there would be significant surface runoff, meaning even larger areas would be affected by torrential incidents. A stronger growth is also predicted for avalanches in connection with climate change. The main causes are the increasingly rapid change of precipitation between rain and snow

due to higher temperatures in general as well as more extreme precipitation in winter. Due to this development, avalanches in the years to come may also increasingly start as forest avalanches, endangering areas that up to now have either never or only rarely been affected.

Due to climate change, new torrent protection systems will be laid out for a design flood increase of 15%. Another key component of the new master plan is the development of a so-called integral torrent concept. This should form the basis for all subsequent expansion and maintenance measures in the area. In addition, torrent risk maps will be created, indicating the so-called torrent risk areas, especially with a view to extreme incidents. This all represents the essential basis for adaptation strategies to climate change in mountainous areas.

With regard to the pending rise in avalanches, avalanche barriers are assuming an increasingly important role in the selective protection of infrastructure from avalanches. Besides avalanche protection constructions, a local avalanche warning system is also crucial to the safety of the local inhabitants, such as the one established in Bavaria by volunteer avalanche commissions as panels of experts for the safety authorities. In addition to the overriding technical measures, the extensive preservation of a viable mountain forest is also of immense importance, as mountain forests have always offered natural protection in securing the infrastructure and population in valley areas.

Left:
Backwater in rainwater drainage system following heavy rain.



Right:
Low water flows in the Rednitz, Regnitz and Main rivers have been improved by the transition of water from the Altmuehl and the Danube. In addition, flooding in the central Altmuehl valley has been reduced.



Heavy rain (flash floods)

One typical effect of climate change is more severe precipitation, which is equally likely to occur throughout the country. From an insurance perspective, damage from heavy rainfall in the long-term is likely to be on the same scale as flood damage from bodies of water. Such heavy rain generally occurs very rapidly and locally. The resulting outflow of large amounts of water in a short time can bring about flash floods. Uncontrolled running water and overloaded drainage systems generally lead to major damage in inhabited areas. Flash floods can occur practically anywhere, regardless of whether there are bodies of water close by or not. It is therefore important, in addition to constructing flood barriers near bodies of water, to also make local precautions a priority. Municipalities and landowners are responsible for preparing themselves for heavy rainfall. Tailored urban development planning, measures for improved local water retention, property protection measures and insurance against property damage are only a few examples of the possible precautions available to help reduce the risk of damage. One good option for towns and districts in dealing with the issue of flooding and flash floods is to conduct a so-called flood audit. The audit asks the question "How prepared are we for floods?" and can weak spots and specific measures for improvement in dealing with flood hazards be demonstrated. The Free State of Bavaria offers funding possibilities for carrying out a flood audit.

Safe provision of water

The water supply in Bavaria comes almost exclusively from groundwater. The future preservation of the quantity and quality of groundwater resources and under altered

climate conditions is therefore of considerable importance. There are approx. 3,400 water extraction systems in Bavaria, each capable of pumping more than 1,000 m³/a of water. A large proportion of the groundwater catchment areas of the extraction systems is to some extent unknown. These as yet unknown catchment areas in public water extraction systems should therefore be identified and shown. Knowing the location of groundwater catchment areas is a prerequisite for protecting drinking water resources from conflicting uses, with respect to quality and quantity. At the same time, sustained efforts to protect groundwater in the area are necessary to secure the quality of drinking water and groundwater.

Provisions for low water, aridity and drought

More frequent and lengthier dry periods resulting from climate change will lead to higher incidences of low water periods in surface water and in groundwater. The use of water from bodies of water can be significantly affected by this sort of extreme event, as indeed can the water itself in its function as a habitat. The drought years of 1976 and 2003, as well as the periods of drought in the recent past, make this a clear and present risk.

To adapt to climate change, both effective long-term precautions and short-term operational measures are necessary in the case of an incident. Suitable management plans that take all water users into account should be developed for low water situations, using regional information on water resources and requirements. Other requirements include the sustainable protection of ground water reserves and sensitive surface waters, as well as the updating of the thermal load plan.



Sylvenstein reservoir.

Comprehensive measures

The tension between drought and flood demands a safeguarding of water resources as well as intensified integrated management. Climate change must also be considered in the implementation of the Water Framework Directive and its associated measures. For example, to ensure the water supply, it is important to include in the regional plan potential, large retention areas for flood protection, low water elevation and drinking water supply, even in priority and reserved areas. The majority of these measures are to be introduced in rural areas. Thus, groundwater recharge through water retention in the catchment areas, restoration of moors and wetlands, and urban drainage measures (infiltration and desealing) are to be supported.

Climate dialogue with industry and communities

Industry is not spared from climate change either. Businesses rely on the supply of water, energy and functional infrastructure. These things need to be guaranteed even under altered climate conditions. Changes, for instance due to extreme weather events, are felt by Bavarian industry at its own companies' locations, as well as by suppliers and customers alike. Businesses are also vulnerable through their supply chains, their products and their services. Adaptation measures prepare for future risks, but they also offer opportunities for innovation. The partners of the Bavarian Environmental Agreement are going to intensify the raising of awareness in businesses, the development of courses of action for businesses and the implementation of adaptation measures. The Bavarian IHK (Chamber of Industry and Commerce) has already stated that

it will provide practical support for adaptation measures and will disseminate findings to the general public. Specific initiatives are planned to develop operational adaptation concepts for workshops as well as a dialogue network to establish the operational management of climate impacts. The Bavarian State Ministry of the Environment and the IHK Bavaria have also developed the first "Climate Agendas" by way of example for the tourism, transport and energy sectors. A climate agenda is a scenario that shows relevant effects of climate change, the resulting opportunities and risks as well as ideas for strategy building and innovations, all tailored to a specific sector. It serves as a navigational aid for individual businesses and provides ideas for addressing climate-related challenges. Meanwhile, in a follow-up project, The Bavarian State Ministry of the Environment has commissioned a detailed study on the construction, trade and manufacturing sectors.

The implementation of climate protection objectives often represents a significant challenge for communities in rural areas with their small municipal authorities. Therefore, in addition to financial support, the seven offices for rural development offer the communities assistance with process management and coordination of concepts and measures through village renovation, agricultural reform and integrated rural development. The offices for rural development that were assigned by the Bavarian State Ministry for Food, Agriculture and Forestry support the communities throughout the whole process, from the awarding of concepts to their implementation, provide information at regional events, local meetings and local council meetings, and help to develop and implement tangible climate protection

projects. They are also supported by a range of seminars at the three schools for village and land development.

Strengthening of the biotope network in climate change

Many habitats in cultivated landscape are separated from each other, making them virtually isolated. The distance from habitat to habitat, as well as the existing structures and barriers between them, determine whether species are able to reach, colonise and, interacting with adjacent species, use the biotope connectivity. Insurmountable obstacles or ones that end in death when trying to overcome them are disastrous. Thus, the permeability of the landscape and a functioning biotope network are key factors in the preservation of biodiversity.

too warm or too dry die out. For animals, the speed with which a species can change its area of distribution is dependent on the ability to change its individual location, while for plants and fungi it is determined by the distribution mechanisms of their seeds or spores. Barriers can significantly affect or even prevent the adaptation of the distribution area to climate change. A closely meshed and functional biotope network cannot prevent species dying out due to climate change, but it can significantly reduce the risk of its extinction.

Premium AEROTEC GmbH is already monitoring the effects of climate change on the company and is working on courses of action – Augsburg site

The biotope network becomes more important with climate change, as many species can or are forced to relocate as a result of global warming. This is generally a slow process in which natural distribution is increasingly successful in regions where weather conditions develop favourably for the species, while the populations in regions that have become





Geohazards

Geological threats in the form of mass movements, such as rock fall, rock slides, landslips and sink holes, have always presented a latent threat to life, infrastructure and material assets, particularly in the Alpine region, but also in other areas in Bavaria. Due to the frequent extreme weather events connected to climate change and the expected retreat of permafrost in the higher altitudes of the Alps, an increase in the frequency and magnitude of geohazard events is to be expected in the future.

Geohazards are particularly disastrous, since they develop considerable destructive force locally and often occur spontaneously, making it difficult to predict when they will occur. There is usually no opportunity to give advance warning, and comprehensive safety measures are not feasible. Precautions are therefore only possible through the early identification of potential risk areas, intensive dialogue with decision makers about the risks and those affected by them as well as long-term avoidance of risk areas. Technical measures to adapt to risk situations will continue to be utilised in individual cases.

The geohazard precaution and information programme comprises the following aspects:

- Steady continuation of the digital geohazard registry for the whole of the Free State of Bavaria to identify potential areas where mass movements could start, since over 85% of slope movement occurs in places where such events have occurred in the past. Currently around 40,400 historic and recent incidents are on file (incident classes: hill slide; rock fall; rock slide; dolina; sinkhole).
- Preparation of reference cards for geological risks based on computer modelling and inspections of areas in especially vulnerable regions in Bavaria for hazard forecasting and assessment. The cards map potential future mass movements from their beginning to their possible end point and serve in particular as a tool for planners and municipalities but also for those directly affected. This process was completed in the Bavarian Alpine region; since 2011 there has been a continuation in other high-risk areas of Bavaria, such as the Alpine foothills and the Swabian and Franconian Jura.
- Continuous risk dialogue with the affected districts, support for infrastructure facilities and citizens as well as the provision of information in the Bavarian Soil Information System (BIS-BY) and on the Bavarian Environment Agency website; continuous expansion of online information on local geohazards on www.bis.bayern.de.
- Metrological observation of particularly sensitive hill slide areas in collaboration with responsible safety authorities.
- Examination of rock slide risks at the permafrost boundary at a permanent tracking station on the Zugspitze massif and integration of the assembled data into international research and monitoring networks on climate change.

2005 summer landslide on the Bacher Alp in Obersdorf

Research and Development



Bavarian Climate Research Network

The competencies available at Bavarian universities and research facilities are as diverse as the topics in climate research: They range from questions on understanding climate systems and their changes, the driving of climate change and development of global and regional climate models, to research on effects and avoidability as well as vulnerability and adaptation to climate change, through to questions on governance and justice, and acceptance research.

These skills should be reinforced and interconnected in a research network. Using targeted support measures, the research profiles of the state universities should be made more precise and extended, and the researchers' network should be improved. What is also planned in the mid-term is to integrate scientists from private universities or those from extramural or departmental research institutions into the network. Preliminary work on the specific thematic, structural and organisational design of the network will begin in January 2016.

Schneefernerhaus Environmental Research Station (UFS)

At 2,650 m above sea level, UFS is Germany's highest research station, barely 300 m below the peak of Zugspitze. It is establishing a globally unique platform not only for the continuous observation of physical and chemical properties in the atmosphere but also for the analysis of processes that affect the weather and climate.



This will form a basis for researching and documenting climate change as well as for developing strategies and proposals for solutions to control the effects of climate change. The official celebration of the 15th anniversary of the environmental research station took place on 6 November 2014.

At UFS they have joined prestigious research facilities into a syndication agreement, and since 2007, they have constituted the "Schneefernerhaus Research Station Virtual Institute". Contributors to this extremely productive research cooperation are:

- German Aerospace Centre;
- German Meteorological Service;
- Karlsruhe Institute of Technology;
- Helmholtz Research Centre for Environmental Health;
- Federal Environment Agency;
- Technical University of Munich;
- Ludwig-Maximilian University of Munich;
- Augsburg University;
- Max Planck Society for the Advancement of Science;
- The Free State of Bavaria with The Bavarian Environment Agency.

The model of the virtual institute has proved to be a success. At the suggestion of UFS, the Alpine high altitude research stations in Italy, France, Switzerland, Austria and Germany will pool their research activities from now on in the form of a "Virtual Alpine Observatory" (VAO). In the long term, this will be extended to include other partners in the climate-sensitive Alpine region and other high mountain regions that are similar to the Alps.

Page 22:
The UFS environmental research station on Zugspitze

Above:
The Bavarian Minister of State for the Environment at the 15th anniversary celebration of the UFS

Bavarian Climate Report – Climate Change, Effects, Activities for Adaptation and Research

Climate change is a global issue that creates regional challenges for us. The intention of the Bavarian Climate Report is to present the important changes in the climate in Bavaria. For the first time, the findings on climate change in Bavaria will be summarised, the effects on different areas of the environment and life will be illustrated and the adaptation and research activities of the Free State of Bavaria will be presented. This will provide a comprehensive basis for action at a regional level.

The Bavarian Climate Report is being developed under the leadership of the German Meteorological Service, The Bavarian Environment Agency and the Schneefernhaus/Zugspitze Environmental Research Station (UFS).

The Bavarian Climate Report will be presented for the first time in the lead-up to the World Climate Summit in Paris.

The report thereby supplements the Free State of Bavaria's environmental reporting and draws attention to the future task of climate protection from the perspective of climate protection in 2015.

Among other key issues are:

- climate change in Bavaria – past and future: what characterises the “white-blue climate” in Bavaria? (weather conditions, temperature, precipitation, snow cover etc.);
- climate impact (impact on society) and adaptation: what does climate change mean for Bavaria? (water supply and water management, soil, agriculture, forestry, geohazards and natural hazards, health and tourism, industry, trade, traffic and energy supply, Alps etc.).

Sector-specific Research

Energy technology and energy efficiency

The Bavarian State Ministry of Economic Affairs and Media, Energy and Technology primarily focusses its activity on energy research in four areas: energy production, energy efficiency, storage and grids. The main emphasis here is on the specific application in industry but also in the private domain. Prominent centres for this research activity are, among others, the The Bavarian Center for Applied Energy Research (ZAE) and the Nuremberg Energy Campus (EnCN). Both are sponsored by the Free State of Bavaria.

The “Bavarian Energy Research Programme” supports businesses with the research, development and application of new energy and energy saving technology, as well as by conducting relevant studies. Typical goals include improving efficiency and environmental compatibility, reducing dependency on non-renewable energy sources, or enhancing the security of the energy supply. Collectively, the programme makes a valuable contribution to achieving the national and international goals of improving energy efficiency, saving energy, increasing the use of renewable energy and reducing energy-related CO₂ emissions.

Eligible programmes are those with highly innovative content that, as a result of this



research, can mitigate significant technical or economic risks. Small and medium-sized businesses in particular are supported by this programme as they can receive an increased level of funding depending on the specific intention.

Woodland, forest and wood climate research

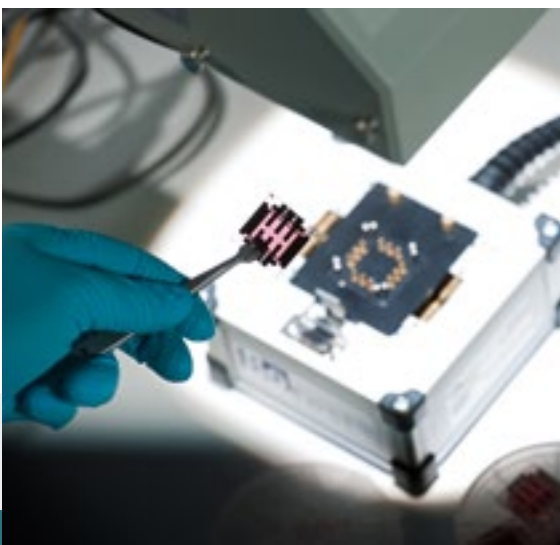
Woodlands, forestry and the use of wood provide a significant contribution to climate protection through the capture of CO₂, the storage of carbon and the reduction of fossil fuel usage. On the other hand, they are particularly affected by climate change, especially by extremes in weather and pest infestation. The long lifecycle and useful life of forests require far-reaching decisions well into the future – despite considerable uncertainty. In order to develop robust strategies for the forestry business and advise forest owners, it is necessary to clarify open questions and minimise the uncertainty around such long-term decisions as much as possible. Sector-specific research also helps establish a suitable knowledge and decision base for forest owners so that the aforementioned climate protection benefits can be attained and to reduce the disadvantages of climate change. Last but not least, their perspective is also designed to span areas of interaction with downstream timber operations.

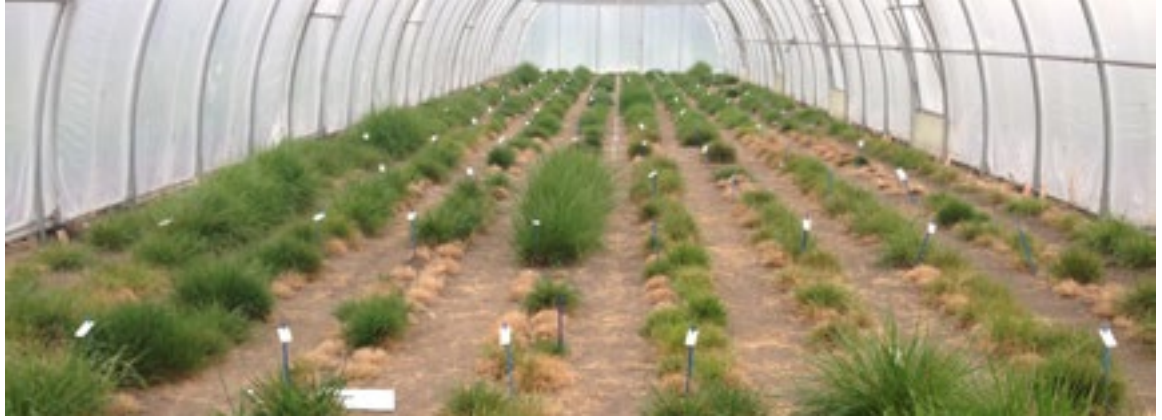
Above:

Research into hydrogen storage – distillation apparatus for material separation

Below:

Research into the production of printable photovoltaics – measuring the efficiency of organic solar cells





Pre-selected populations of German ryegrass, samples of meadow fescue, and selected interspecific hybrids in open land in a controlled test of tolerance to temporary drought stress

The focus of research on the effect of climate change on the woodland, forestry and wood sector continues (cf. www.lwfdirkt.de/klimasymposium) and the findings from the research and development work will be made more useable for forest owners and the forestry industry. Research projects currently being carried out include:

- analysis of tree species as to their distribution boundaries and the location-related growth potential of the main tree species in Bavaria;
- implementation and further development of the Bavarian location information system;
- investigation into the protection of the genetic quality of forest reproduction material for tree species important to climate change;
- potential for long-term monitoring of climate change in forests with state-of-the-art satellite-based remote sensing and;
- development of management strategies for controlling the dieback of ash trees.

Agricultural strategies in climate change

Agriculture is both a victim of and contributor to climate change. Assessment of the impacts of climate change and development of appropriate recommendations for practical action are key areas of activity for The Bavarian State Research Center for Agriculture and the Bavarian State Institute for Viticulture and Horticulture (LWG). Changes in vegetation and soil fertility are being monitored long-term, and strategies for accordingly adapted agriculture will be developed based on these findings and those of climate modelling.

The main challenge for agriculture comes from increasing water scarcity and heat stress in summer. The water deficit is accompanied by

a lack of nutrients. Extreme weather events will also raise the risk of lost harvests. The higher carbon dioxide content in the air, while positive for plant growth, is not expected to be able to fully cancel out these losses. In addition, changes in precipitation and temperature profiles will increase the requirement for plant, soil and water protection.

Appropriate measures for adaptation are being compiled in a number of research projects. Adaptation is possible by modifying the means and techniques of production. Varieties of grain and grass are being developed, among other techniques, through the selective breeding of appropriate characteristics with the help of a rolling greenhouse, which can test the plants with high levels of drought stress. New strategies are being developed for the anticipated problems with water supply and water quality, plant nutrition, soil protection and the protection of cultivated plants from new diseases and parasites. With the ultra-modern moving fields system, for example, it is possible for the first time to quantify root growth in plant stock and, thereby, to identify plants with better water and nutrient absorption. The first results are already available. Projects for optimising agricultural processes, particularly biogas generation, are among the activities taking place with the aim of preventing greenhouse gases.



Sustainable production and climate protection in rural areas, e.g. alternative energy plants

Agriculturally cultivated plants have a special importance in the sustainable production of regenerative resources, as well as their material and energetic use: It is not only food that is produced from them but also renewable energy, albeit it to a lesser extent. This use of land is, however, not without controversy. Uniting ecological aspects, climate protection and the economic use of bioenergy is not always straightforward. Therefore, The Bavarian State Ministry for Food, Agriculture and Forestry (StMELF) has for a number of years now supported research work with the aim of reducing undesired effects and defining the benefits of bioenergy more precisely. Improved cultivation methods and new crops are being researched and tested at institutions belonging to StMELF. The substantiated results obtained are integrated directly into the farmers' advisory service.

The Technology and Support Centre (TFZ) in Straubing is testing new and less well-known varieties: crops such as quinoa and sorghum can ripen in only three months, even in dry conditions – a clear advantage with regard to future climate change. For critical areas, such as steep slopes, or in sensitive areas like water protection areas, permanent crops are particularly suitable; hence, cup plant, switchgrass, reed canary grass, rye brome and Virginia mallow are being analysed in a series of tests.

Research work by The Bavarian State Research Center for Agriculture shows that maize – one of the highest yielding biogas plants – can be enriched not only visually but also in the scope of biodiversity: Maize in combination with runner beans, sunflowers or mixtures of wild

plants enriches agricultural biodiversity. Intelligent mixtures with leguminous plants cause biological nitrogen fixation, thus reducing the need for nitrogen fertilisation. Well thought-out crop rotation with humus-increasing ley grasses, e.g. as a nurse crop in grain stocks, improve the humus balance and keep carbon in the soil. Flower strips or a rich mix of wild species, which have for some years been the subject of research by the LWG in Veitshoechheim, provide a healthy supply of flowers in the agricultural landscape. These permanent crops not only enrich our landscape visually they are also attractive to wild animals and insects. If the establishment of perennials is successful, stable yields that are also relatively good in droughts will be possible from the second year on.

In addition, short-rotation plantations (fast-growing tree species in agricultural areas) offer a good opportunity as a further element of the diversification of the plant range. The Bavarian State Institute of Forestry is involved, among other things, with the topics of hydrology, fauna and yields for cultivation as well as with detailed studies on the supply and quality of wood for energy.

Although similar in appearance to the maize widely cultivated as a biogas substrate, sorghum is extremely drought-tolerant and ripens quickly, making it the subject of in-depth research at the TFZ, Straubing.



Left:
Profile recording provides information on the effect of climate change on native soils

Right:
An EC station primarily measures the exchange of gas between soil and the atmosphere, shown here in a water meadow habitat in Otterbachtal

Effects of climate change on conservation

Due to the dramatic change in precipitation and temperatures, climate change for many species means the further deterioration of living conditions. Even if some species are able to profit from climate change, it is not certain that their resources will be similarly favoured or that they will be able to migrate to regions with suitable living conditions. For example, species that need old trees can only migrate if other suitable old trees are available. Climate change also carries with it the increasing risk of extreme weather events, to which some newly established species may fall victim. Thus, the strengthening of existing endangered species and symbiotic communities as a whole in climate change remains a primary objective.

Animal, plant and fungus biotypes have the best future prospects with regard to global climate change in extended, species-rich and robust habitats. Larger, more vigorous populations are best able to defend themselves against invasive species and gradual changes to their habitat. Therefore, the protection, optimisation and interconnection of current valuable habitats are some of the most important methods of adapting to climate change. Specific measures should also be taken to preserve particularly vulnerable species. This is why many traditional conservation goals remain a priority in climate change, such as the implementation of species protection programmes and the improvement of the ecological status of protected areas. Some of the specific research projects planned include the "functioning of the biotope network for wild plants and animals", particularly for "climate refugees", and the "spatial planning and eco-sociological studies on nature-compatible

alternatives for winter tourist destinations in the Bavarian Alps."

Bavarian landscape in climate change

Bavaria's soils store huge amounts of carbon. They contain four times as much climate-damaging carbon dioxide as is emitted in Germany every year – equivalent to just under 3 billion tonnes. Reliable results are needed from climate research in order to continue protecting our soil going forward. As part of the project network "Bavaria's landscape in climate change", scientists from The Technical University of Munich are investigating the effects of climate change on domestic soils in three sub-projects. Varying landscapes, such as the Alpine upland, the Ammer catchment area or the Bavarian forest, are being examined in detail – primarily for their resilience to climate change. In order that these ecosystems can continue to fulfil their vital role as carbon stores in the future, the groundwork must be properly laid now and suitable adaptation strategies must be developed.

Centre for Urban Ecology and Climate Adaptation

Towns and urban nature react particularly sensitively to the effects of climate change due to their constant state of flux, redensification, the sealing of open spaces and displacement of animals. The design and development of urban nature is therefore a part of the Bavarian climate adaptation strategy. Urban nature means both quality of life and protection, since at a time of climate change and threatening heat waves, urban green spaces bring irreplaceable ecosystem services such as shade, moisture preservation, an air-lane effect and a place to relax – especially for older people – as well as protecting biodiversity. Urban green



spaces therefore require a design with climate adaptation in mind but also the opportunity for natural distribution aligned to the protection of nature. Since 2013, on behalf of The Bavarian State Ministry of the Environment, the Centre for Urban Ecology and Climate Adaptation at the TUM has been exploring and developing an integrated strategy for climate adaptation in towns. In detailed and exemplary case studies in new and older areas of three Bavarian towns, the effects of climate change, vulnerability and resilience are being documented, and options for climate adaptation through ecosystem services for a greener infrastructure that take biodiversity into account are being explored. Together with climate protection measures, such as saving energy, increasing energy efficiency and implementing renewable energy at building and neighbourhood levels, integrated urban development climate protection and climate adaptation strategies should be developed and expanded in close collaboration with partner towns.

Resource-saving irrigation of urban green areas

The “Locally adapted irrigation of public green spaces as a contribution to climate moderation in urban habitats” research project (2008–2012) was aimed at optimising irrigation techniques in green spaces. A plant-friendly water supply ensures that the vegetation in increasingly hot towns can evolve its climate-moderating beneficial effects.

“Urban green spaces 2021” – testing stress tolerant climate-trees

As a result of climate change, some of the current species of trees in towns are becoming increasingly weakened, more frequently infested with disease or pests, or dying out completely. Therefore, since 2010, 20 promising species of tree have been undergoing tests in three Bavarian towns under different climatic conditions to check their level of climate resistance. The test results are supported by the pool of experience in the districts participating in the “Bavarian climate-tree network”. Following the auspicious initial results, ten further tree species will be incorporated in the tests in 2015.

“Urban gardening” – vegetables from the roof

Increasing building development in towns reduces green areas and habitats for people and animals. Roof planting, however, brings nature back to the city and gives a valuable boost to the environment, because these plants absorb harmful CO₂ from the air and insulate the buildings. In addition, vegetables fresh from the roof mean short transport routes, providing double protection for the climate. As a result, the LWG has been testing the cultivation of vegetables on thin substrate layers at high levels since 2013.

Left:

Locally adapted irrigation helps to save water and enables the creation of specific green areas, such as roof terraces. Drip irrigation works with low pressure and slowly supplies water directly to the roots, thereby saving energy, soil and water resources.

Right:

Some like it hot: e.g. Spaeth alder trees

Below:

Something for everyone: abundant harvest from a rooftop vegetable garden



Health

The rise in the average global temperature will not only have an effect on the environment but also on human health. A higher death rate is expected due to diseases affecting the respiratory and cardiovascular systems. Exposure to UV radiation may also rise due to climate change and, with it, the risk of skin cancer. An increasing spread of infectious agents may also be a consequence of rising temperatures. As for allergy sufferers, an extended pollen season is likely to increase afflictions.

Research projects on the health implications of climate change are therefore a key prerequisite for developing precautionary and adaptive measures for health protection.

With regard to health, it is the aim of the Bavarian Climate Protection Programme to continue to promote research into the effects of climate change on health in an attempt to improve the skills base and create specific adaptation strategies.

Sewage plants of the future

With the "Sewage plants of the future" study commissioned by the StMUV, new concepts were developed for the process engineering of wastewater treatment. The aim is to achieve even greater energy savings and a reduction in the emission of greenhouse gases than can be achieved through a purely technical optimisation of the existing sewage plants with conventional technology. A number of suggested measures that came out of the study carried out at the end of 2009 have already been implemented and tested in the form of pilot projects at sewage plants in Bavaria.

Operating the usual type of system in small sewage plants (aerobic slurry stabilisation) leads to comparatively high power consumption. However, in a pilot project sponsored by state funds, a small municipal sewage plant was converted to anaerobic slurry stabilisation technology. This is a purification process with comparatively low power consumption that produces sewage gas and is already used efficiently for large plants serving a population of around 25,000 or more. The conversion and test operation of the sewage plant were scientifically monitored, and it emerged that such a conversion is technically feasible and its operation is economically viable. Using this technology, the conversion of about 100 other similar sewage plants in Bavaria can reduce power consumption and increase sewage gas production by up to 10%.

Refitting a septic tank for integrated gas storage for 16,000 residents at the sewage plant in the market town of Bad Abbach and converting it to anaerobic slurry stabilisation



Measures and funds in 2015/2016 two-year budget

Measures/Programmes	Funds [€m] 2015/16
Mitigation of climate change as an international model	
Energy-related restoration of state buildings	50
10,000 Houses Programme	14.5
Climate protection through wood use	Climate agent "forest" (see below)
Development of renewable energies	3.0
Bioenergy – renewable resources	11.2
Geothermal energy	2.0
Funding priority: Local climate protection	8.6
Moor restoration	6.6
Moor protection in forests (StMELF)	0.3
Bio-CO2 storage meadows	3
Bavarian Climate Alliance	2.6
Regional adaptation to climate change impact	
Forest restructuring	11.25 Climate agent "forest"
Mountain forest campaign	(incl. wood use and research)
East Bavarian Forest Initiative (WIO)	
Water management	14
Climate dialogue with industry and communities	1.2
Strengthening the biotope network in climate change	0.8
Geohazards	1.0
Research and development	
Bavarian climate research network	0.2
Schneefernerhaus environmental research station	1.0
Sector-specific research	1.2
Energy technologies and energy efficiency	29.0
Climate research woodland, forest, wood	Climate agent "forest" (see above)
Agricultural strategies in climate change	1.46
Sustainable production and climate protection in rural areas e.g. alternative energy plants	5.3
Effects of climate change on conservation	0.8
Bavarian landscapes in climate change	1.8
Urban nature research	1.2
Health	0.6
Sewage plants of the future	0.2

Bayern. Die Zukunft.

Publisher: Bavarian State Ministry of the Environment
and Consumer Protection (StMUV)
Rosenkavalierplatz 2, 81925 Munich, Germany

Internet: www.umweltministerium.bayern.de
E-Mail: klimaschutz@stmuv.bayern.de
Design: www.studio-botschaft.de
Photos: Title - 1stphoto/fotolia; p. 4 - Rolf Sturm; p. 5 - Michael Heinrich, München;
p. 6 - GWG München; p. 6 bottom - FLAD&FLAD Communication GmbH
p. 7 top - Katrin Heyer; p. 7 bottom - IB Wasserbau Ringler GmbH, LL;
p. 8 and p. 9 - FLAD&FLAD Communication GmbH; p. 10 - Felix Brundke;
p. 11 top - Josef Stangl; p. 11 bottom - StMUV; p. 12 - Lederer, StMUV;
p. 13 - Grammo / photocase.de; p. 14 - Michael Friedel; p. 15 - StMELF;
p. 16 - Binder Luftbild, WWA Deggendorf; p. 16 - Binder Luftbild, WWA
Deggendorf; p. 17 left - Walter Bachmann, StMUV; p. 17 right - Stefan
Hollrieder, WWA Traunstein; p. 18 left - Hofmann, WWA Weilheim;
p. 19 - WWA WM; p. 20 - Premium AEROTEC GmbH; p. 21 - Poschinger,
Bavarian Environment Agency; p.22 - M. Neumann (UFS GmbH);
p. 23 - StMUV; p. 25 top - © encn / Kurt; p. 25 unten - © encn / Thomas
Lother; p. 26 - Andrea Wosnitza; p. 27 - Dr. Maendy Fritz;
p. 28 - Prof. Dr. Jörg Völkel; p. 29 - StMELF;
Printing: deVega Medien GmbH
Date: September 2015
© StMUV, all rights reserved

Printed on 100% recycled paper

ClimatePartner^o
climate neutral

Print | ID 11342-1511-1003

This publication is issued free of charge as part of the public relations activities of the Bavarian government. It may not be used for canvassing purposes by political parties, canvassers or electoral assistants within a period of five months prior to an election. This applies to state, parliamentary and municipal elections. During this period, in particular, its distribution at election rallies and party information stands, as well as its insertion, printing and affixing to any party and/or political information or advertising material constitutes misuse. Equally prohibited is its forwarding to third parties for political campaign purposes. Even if there is no election forthcoming, this brochure may not be used in such a manner that it could be construed as support by the state government for specific political groups. The parties are permitted to use the publication as a source of information for their own members. If used for journalistic purposes – even in part – the source must be quoted and a specimen copy provided on request. This work is protected by copyright. All rights are reserved. The brochure is made available free of charge; any sale of the brochure is prohibited. This brochure was compiled with the greatest of care; however, no liability for its correctness or completeness can be assumed. We do not accept responsibility for the contents of any external internet sites.

www.klima.bayern.de