COUNTRY REPORTS ABOUT THE IMPLEMENTATION OF SUSTAINABLE LAND USE IN DRINKING WATER RECHARGE AREAS

GERMANY (BAVARIA)

Version 3
06 2017

1.Introduction

This questionnaire will regenerate the Status quo reports for each country about actual land use activities and their relation to water management and flood management, evaluation of gaps and SWOT analysis.

Task Please provide breafly description about actual land use activities and their relation to water management in your country

Current land use activities are strongly related to water management and water protection in Bavaria. The valid federal and state acts and ordinances regulate land use activities for areas requiring a particular protection (e.g. inundation areas or water protection zones). Especially in water potection zones, zone-specific ordinances are negotiated based on state-of-the-art knowledge and techniques to implement adequate water protection measures in sensitive areas. Since a few decades, water suppliers and farmers further close voluntary private-law contracts regulating land use activities in and beyond the borders of drinking water protection zones (DWPZ).

Moreover, water management plays an important role in Bavarian forestry. For many years, a primary objective of forestry has been to continuously convert (spruce) monocultures to stable and vital mixed forest stands. This conversion process is still ongoing and represents a promising approach to enhance water protection and ecological diversity in forest areas.

However, further advances have to be made to ensure a sustainable water management in terms of water quality and water quantity in the future when faced with climate change.

2. Water supply resources, protection and management policy on national and regional level

2.1 Water management

➢ Which water resources (groundwater, surface water-lakes, reservoirs…) are used for water supply and in which rate?

All values described in the following are based on data obtained for the year 2013. An amount of 1,039,980,000 m³ was specified as the total public water supply in 2013.

- 82% (852,162,000 m³) thereof was gained from extraction systems located in Bavaria and
- 18% (187,818,000 m³) from external procurement (e.g. water suppliers from neighbor states).

Focusing on the water amount gained from Bavarian water extraction systems, 71% was extracted from groundwater resources, 18% from springs and 11% from surface waters (including bank filtration) (LfStat, 2015a).

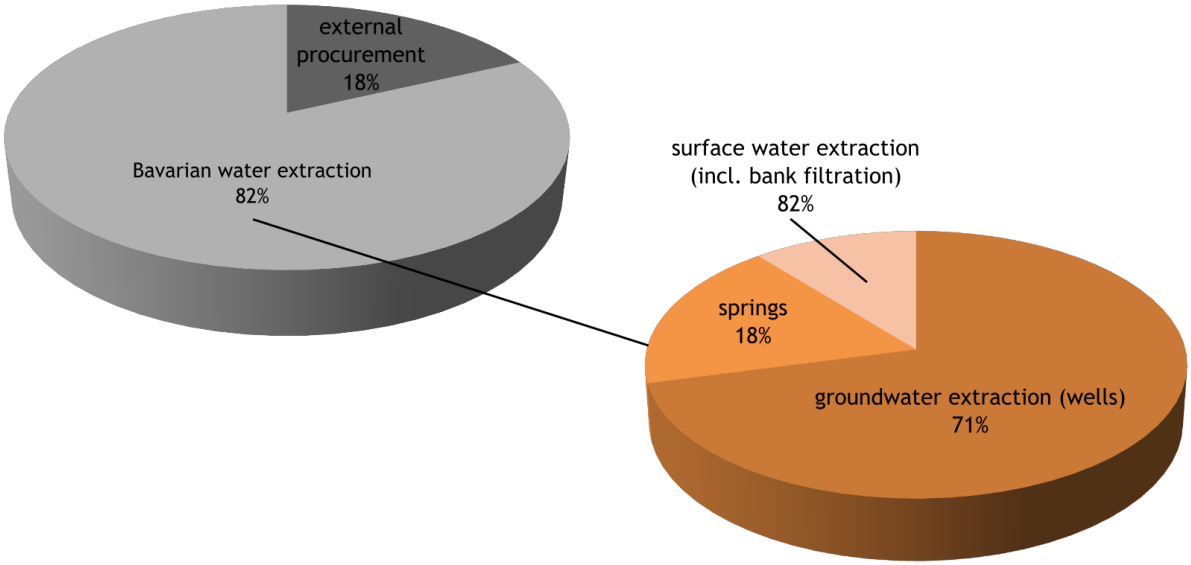

Figure 1 Public water supply and percentage distribution of relevant resources in Bavaria in 2015. Data provided by LfStat (2015a).

In 2013, the non-public water supply reached a total amount 2,787,324,000 m³ whereof 94% (2,608,578,000 m³) has been gained from water extraction systems located in Bavaria (LfStat, 2015b).

➢ For which purpose is this water used?

70,3% of the public water supply has been supplied to end consumers, whereof 80,4% has been supplied to households and 19,6% to industrial and other costumers. 17,5% of the total water supply has been used for further distribution, while 2,4% has been consumed by the water utility itself. The remaining amounts are assigned to water losses and measuring errors (LfStat, 2015a).

Most of the water from non-public water suppliers has been used for energy supply (68%, 1,884,506 m^3) as well as in the manufacturing sector (29%, 796,331,000 m^3). These two activities represent the main water consumers from the non-public water supply. The third largest amount has been used in mining industry (1%, 37,936 m^3). The remaining amounts are used by further economic departments, such as the construction or traffic industry (LfStat, 2015b).

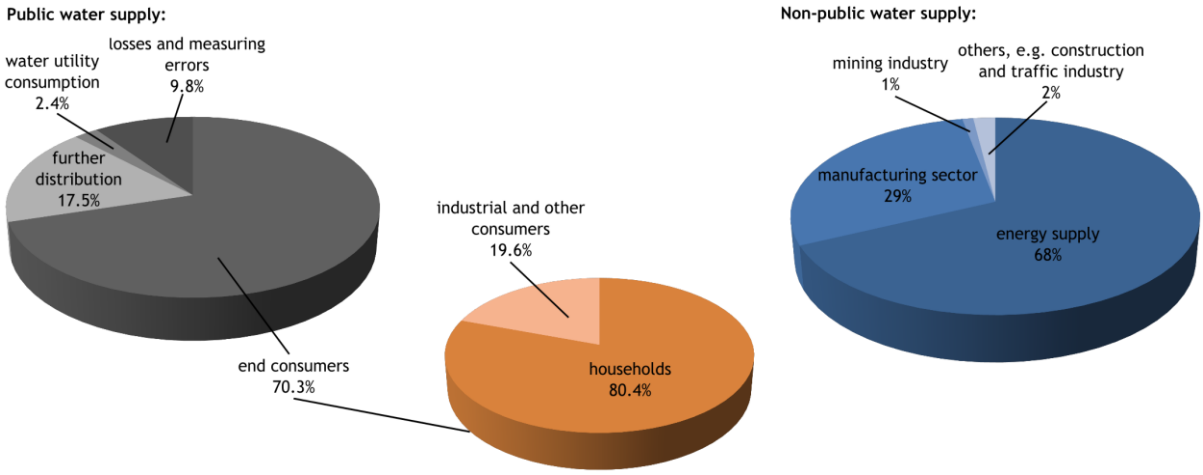

Figure 2 Distribution of pubic and non-public water supply in Bavaria in 2015. Data provided by LfStat (2015a) and LfStat (2015b).

➢ Who control and manage water policy?

The Bavarian Environmental Agency (LfU) gives technical support for the implementation of state policy and elaborates different drafts for the control and management of water policy.

On the local level, the State Offices for Water Management (WWA) perform controls with regard to compliance with the regulations and manage water policy. The WWA further undertakes consultancy tasks for technical aspects in terms of water management to support and advice the enforcement authorities (governments and county offices) (StMUG, 2013).

- Who control and manage drinking water policy?

For dringking water policiy the control and management is structured similarly to the water policy, i.e., LfU gives technical support for the implementation of state policy, while WWA performs controls with regard to compliance with the regulations and manage water policy

- The legal and administrative organization of water policy?

The legal and administrative organization of water policy in Bavaria is divided into three parts: the highest level public water authority (Bavarian State Ministry of the Environment and Consumer Protection, StMUV), the upper public water authority (district governments) and the lower public water authority (county offices). These bodies represent executive authorities. The highest level public water authority assumes the control of water management and legal supervision on the state level. The upper public water authority coordinates and bundles the administrative and technical supervision of water management to ensure a consistent administrative process implemented by the county offices (StMUG, 2013).

- The legal and administrative organization of drinking water policy?

Following Art.83(1) of the Bavarian constitution (BayVerf), the water supply ranks among the responsibilities of the municipalities. Additionally, Art.57(2) of the Bavarian municipal code (BayGO) obligates the municipalities to establish and to maintain the drinking water supply. It is common practice that municipalities establish water supply associations in order to benefit from a greater supply network. According to the Drinking water ordinance (TrwV), the health department has the responsibility of a monitoring authority to ensure the fulfillment of water quality and quantity requirements. Moreover, the health department is entitled to issue directives to the water supplier in case of non-compliance or non-performance of regulated requirements as well as in case of reasonable concern of the human health.

- Who manage and coordinate implementation of state policy in scope of water?

According to Art.63 of the Bavarian water act (BayWG), the implementation and execution of legislation of state policy in scope of water is fulfilled by the county offices and governments in Bavaria in cooperation with the LfU and the WWA. The LfU gives technical support for the implementation of state policy and elaborates different tools and drafts for environmental declarations and reports on state level. The WWA provide support for the county offices and governments in the

scope of water management. The WWA are directly involved in the implementation of state policy and manage and coordinate these processes.

- Please provide a list of legislation related to water management, their protection and management of floods/droughts (land use legislation/polices, Water management legislation/policies, groundwater and surface water management plans and other legislation)

Federal level (Germany)

The German Federal Water Act (Wasserhaushaltsgesetz - WHG) from 31 July 2009 includes the national implementation of the Water Framework Directive (2000/60/EC) from 23 October 2000, the Floods Directive (2007/60/EC) from 26 November 2007 as well as parts of the Groundwater Directive (2006/118/EG) from 12 December 2006;

- §6 - §24 regulate common determinations for water resources management, relevant for all types of water bodies;
- §25 - §42 regulate specific water management determinations for surface waters;
- §43 - §45 regulate specific water management determinations for coastal waters;
- §46 - §49 regulate specific water management determinations for groundwaters;
- §50 - §107 determine specific legal regulations, including e.g.:
    - public water supply (§50 - §53), with §52(5) integrating the obligation to pay compensations for economical disadvantages resulting from legal limitations for orderly farming in water protection zones,
    - sewage disposal (§54 - §61),
    - handling of substances hazardous to water (§62 - §63) and
    - flood risk protection (§72 - §81);

Concrete determinations for the specific regulations in the WHG are given by different, subject-related laws and ordinances:

- Wastewater Charges Act (Abwasserabgabengesetz - AbwAG): legal regulations of dues for the discharge of effluents into water bodies;
- Wastewater Directive (Abwasserverordnung - AbwV): legal regulations for the discharge of effluents into water bodies;
- Water Board Act (Wasserverbandsgesetz - WVG): law regulating the implementation of water and soil associations;

- Groundwater Ordinance (Grundwasserverordnung - GRWV): legal ordinance for the protection of groundwater integrates the requirements of the Groundwater Directive (2006/118/EG) from 12 December 2006;
- Drinking Water Ordinance (Trinkwasserverordnung - TrwV): legal ordinance to protect the human health from negative effects of water pollution by integrating requirements for the drinking water purity and consumability;
- Surface Water Ordinance (Oberflächengewässerverordnung - OGewV): legal ordinance for the protection of surface waters;
- Ordinance for the self-monitoring of water supply and sewage plants (Eigenüberwachungsverordnung - EÜV): regulates the monitoring obligations of water supply and wastewater plant operators

State level (Bavaria):

The Bavarian Water Act (Bayerisches Wassergesetz - BayWG) from 25 February 2010 includes the implementation of the Water Framework Directive (2000/60/EC) from 23 October 2000, the Floods Directive (2007/60/EC) from 26 November 2007 as well as parts of the Groundwater Directive (2006/118/EG) from 12 December 2006 on state level;

- Art.14-30 integrate water resources management regulations;
- Art.31-55 integrate additional water management regulations (beyond regulations of WHG), e.g. compensations of additional expenditures for the construction and operation of agricultural and silvicultural operation facilities resulting from limitations in water protection zones;

Concrete determinations for the specific regulations in the BayWG and the WHG are given by different, subject-related laws and ordinances:

- Ordinance on Facilities for Handling Substances Hazardous to Water and on Specialist Firms (Anlagenverordnung – VAwS): legal ordinance integrates requirements for water facilities to achieve the protection goals of the WHG;
- Bavarian Wastewater Levy Act (Bayerisches Abwasserabgabengesetz - BayAbwAG): Bavarian law for the execution of the sewage tax law Wastewater Levy Act (AbwAG);
- Laboratory Ordinance (Laborverordnung – LaborV): legal ordinance for the admission of test laboratories for water analysis;
- Ordinance for private experts in water management (Sachverständigenverordnung Wasser – VPSW): legal ordinance for private experts in water policy, regulating the requirements for their recognition, the recognition process and obligations;

- Ordinance for plans and supplements in water management procedures (Verordnung über Pläne und Beilagen in wasserrechtlichen Verfahren - WPBV): legal regulation defining different types and related contents of documents required in water management procedures

2.2 Drinking water protection zones

➢ Which are criteria for determining water protection zones?

According to §51 in the WHG, water protection zones are determined as far as it is required for the general well-being. In this context, three different criteria are named:

1. the protection of water bodies which are assumed to be of particular interest for currently existing or prospective public water supply;
2. to quantitatively enrich the groundwater aquifer;
3. to protect the water bodies from harmful rainfall runoff and discharges from agricultural lands carrying soil particles, fertilizers or pesticides.

➢ What limitations and restrictions have been declared within the water protection zones?

Basically, limitations and restrictions are mostly adapted to site-specific characteristics and thus may differ between different water protection zones. However, general valid requirements are given by a model ordinance of the LfU (LfU, 2003).

Within the model ordinance, general limitations and restrictions are made for

- activities intruding into the subsurface (e.g. limitations for activities intruding into aquifer protective layers),
- handling of substances hazardous to water (e.g. restrictions for the construction and use of installations for the treatment or distribution of substances hazardous to water),
- wastewater treatment and disposal (e.g. interdiction to implement overflow tanks for the discharge of rain or mixed waters),
- traffic routes, spaces for specific purposes and housegardens (e.g. interdiction to implement storage facilities for construction materials),
- structural installations (e.g. interdiction to designate new building areas) and

- agricultural, silvicultural and horticultural land uses (e.g. interdiction to spread sewage sludge).

➢ Who control and manage legal acts for determination of drinking water protection zones?

Following Art.31(2) BayWG the controlling and managing tasks of legal acts for the determination of drinking water protection are assumed by the local authorities.

➢ What is the procedure of drinking water protection zones implementation?

In general, the WHG prescribes that water protection zones have to be designed based on state-of-the-art regulations and techniques. The water supplier engages a hydrogeological expert bureau to elaborate and assemble the required documents.

○ DWPZ are designed based on the field investigations and desk studies. How DPWZ are transferred to the space and how DWPZ are considered in the spatial planning procedures?

The assessment of water protection zone borders starts with the spatial delimination of the hydrogeological catchment area and thus with an assessment of aquifer properties. This investigation also comprises an assessment of the protective function of aquifer protective layers. Following a method introduced by HÖLTING et al. (1995), a mean protective effect of these layers can be achieved if the percolation time until the water reaches the aquifer is at least equal to 3 years. In respect of water flow length and residence time, the protective effect of the aquifer is taken into account as well. By taking possible detrimental acts and facilities as guiding criteria for the spatial delimination, the subsoil properties help to define the spatial extent of the area in which the general requirements of water protection are insufficient. The elaborated area represents the outer boundary of the water protection zone (zone III).

The spatial delimination of zone II is based on further protective requirements for the drinking water protection. This includes the assessment and implementation of hygienical requirements. Especially human-pathogenic germs should almost completely be degraded before the water arrives at the extraction well. A common empirical approach for this assessment is represented by the 50-day-isochrone, meaning that each water particle on the border line of zone II should take 50 days before reaching the extraction well. This isoline has to be established for the maximum extraction rate of the planned wells and for minimum input from

the hydrological boundary conditions. Despite the aquifer properties, the effects of the aquifer protective layer can be considered as well. Therefore this layer has theoretically to be reduced by a thickness of 4m to take possible interferences in the aquifer protective layer outside the DWPZ into account.

However, this approach ist not applicable for karstic or fractured aquifers since a complete degradation of human-pathogenic germs can not be ensured due to reduced filtering and sorption effects. In this case, a more central role is assigned to the protective effects of aquifer protective layers which are thus considered for the border demarcation of protection zone II.

Generally, a minimum radius of 10m has to be maintained for the assignment of protection zone I. The criteria for the spatial delimination of zone I are similar or stricter to those for the determination of zone II (LfW, 1995; LfW, 1996; LfU, 2010a).

- Who are parties with whom DWPZ are discussed (e.g. local communities, water managers, land owners, any other party)?

  - appointed expert bureau: elaborates expert opinion
  - local authority: legally and formally verifies the submitted documents
  - WWA: officially appointed expert, verifies the technical aspects of the documents
  - Agency for Agriculture and Forestry: officially appointed expert for agricultural and forestry aspects
  - affected land owners
  - affected municipalities
  - concerned associations

- Are borders of DWPZ negotiated and agreed?

Negotiations or objections about the borders of drinking water protection zones can be part of the legal procedure of water protection zone implementation. At this stage, borders can be negotiated and also agreed in case the objections are reasonable and target-oriented. Since the borders are a result of field investigations and desk studies, other suggestions have to ensure a similar protective effects. Once the protection area has been determined borders are fixed and can not be negotiated any more.

- Are interdictions, limitations and measures negotiated?

  During the planning process, an engineering office (appointed from the water supplier) prepares an expert opinion. Already at this stage, the water supplier involves the concerned persons and parties to timely recognize conflicts in terms of possible limitations that should be eliminated. In a next step, the water supplier submits the proposal to the local authority. The local authority verifies the proposal in agreement with the WWA and the responsible Agency for Agriculture and Forestry. Both have a right of veto in case of technical deficiencies and/or insufficient/excessive requirements in the context of agricultural, silvicultural and horticultural land use limitations and restrictions. The negotiations have to be implemented by the water supplier or the appointed engineering office, respectively. The final application has to be submitted to the local authority. Once the expert opinion achieved an appropriate state, the local authority elaborates the official certificate according to Nr. 35.1.2.2 VwVBayWG.

  In a next step, the local authority makes these documents available to all affected parties and persons in the concerned municipalities. All well-founded objections resulting from the involved public will be negotiated before the local authority legislates the water protection ordinance (LfU, 2010a).

- Is there any coordination during this process?

  The water supplier coordinates the implementation process whereas the local authority coordinates the legal act of the implementation process

- In what extend opinions from the possible procedure must be accepted and how they are accepted?

  Opinions from affected persons and concerned parties have to be heard. The extend to what these opinions are accepted and the procedure of acceptance are part of the legal procedure.

  All persons and parties who raised objections during the public engagement are invited to a public hearing to clarify and discuss the stated objections. The objections are accepted if the technical and legal authorities agree to the objections.

- How DWPZ borders are considered in the space and in the spatial planning process?

  Yes, borders of DWPZ are considered for each spatial planning process.

- Are borders of DWPZ drawn so that they are following land plot (cadastral / parcel) borders?

  As far as possible, borders of DWPZ should be drawn so that they are following land plot borders (LfU, 2010a).

- Are borders of DWP drawn so that only design criteria are considered, no matter what are the ownership relationships in space?

  In general, the selection and thus the demarcation of areas for new water protection zones also considers existing infrastructures which can adversely affect the purpose of the protection zones. Moreover, interferences in property rights are avoided as far as possible meaning that ownership relationships are considered.

- Is the list of plots (cadastral parcels) positioned on the DWPZ prepared and it is publicly available or even published in the official documents?

  An extract of the real-estate plots is published in the announcement of the official proposal of the water protection area ordinance. The announcement is published to engage the public in the legal procedure.

- Who and how is exercising control over the surface of DWPZ?

  The responsibility to control the implementations of measures as well as their succes (in terms of enhanced water quality and/or quantity) is legally transferred to the water supplier. The water supplier thus performs a self-monitoring.

  Moreover, the local authority and the WWA also control the surface of the DWPZ.

- How the breaches of the requirements defined on DWPZ are penalized?

  According to Art.74 BayWG a penalty of up to 50.000€ may be imposed in case of negligent or intentional non-compliance.

2.3 Floods/droughts management

- In which way management of floods and droughts is regulated in your country?

Floods

Basically, a risk is always related to the vulnerability of the human health, the environment (in the sense of human benefits), cultural heritage and economic values to a certain hazard. Thus, the goal of flood risk management is to protect these goods from flood hazards.

The requirements given by the Floods Directive are integrated in the WHG as well as in the BayWG. In Bavaria, flood management plans are developed based on three steps:

1. preliminary risk assessment based on a status analysis of the river catchments;
2. creation of flood hazard maps and flood risk maps for risky areas;
3. development of flood risk management plans;

In order to develop comprehensive flood risk management plans for Bavaria, flood management strategies are based on four priorities: *prevention*, *protection*, *provision* and *after-care*. These priorities are key elements of the Bavarian flood management programme *'Aktionsprogramm 2020plus*' (StMUV, 2014).

The *prevention* of flood risks includes e.g. the leaving of inundation areas and the prevention of building developments on these sites to avoid an exposure of humans and economic goods to flood risks. Moreover, a removal or a relocation of infrastructures are considered as well under this item.

The following priority of flood risk management is the *protection*. Protection includes any kind of structural and non-structural measures fostering the technical flood protection as well as the natural water retention in the catchment. These may include the construction of dykes and flood control reservoirs or the implementation of water management measures in the catchment, respectively.

The *provision* of flood risk management integrates flood forecasting, the planning of support measures for the emergency case (both in the sense of information provision) as well as improvements of behavioral precautions by sharpening the public awareness.

As a result of a flood event, *after-care* measures have to be performed in order to recover and to check the effects of the flood event. In a first step, the impacts for individuals, societies and the environment have to be recovered. In a following step, the obtained data are used to review, to

extend and also to revise fundamental aspects of flood risk management strategies (StMUV, 2014).

Droughts

In terms of drought management, the LfU established a low-water information service in 2008 (LfU, 2016c). This service performs a continuous monitoring of the already existing meteorological and hydrological monitoring networks. The data is used to run forecasting models and to assess possible impacts of droughts. The provided data further supports the management as well as the decision-making process in case of droughts.

- Do you have flood/drought risk assessment done on national level?

A flood risk assessment has been done in Bavaria within the scope of the implementation of the European Flood Dircetive. Moreover, a risk assessment as well as adaption strategies for floods and droughts have been elaborated withing the Bavarian climate adaption strategies project (BayKLAS) (StMUG, 2009).

- If yes, have you designated areas for which significant risk of flooding/droughts is estimated?

Current Bavarian research projects are focusing on this subject for flash floods, where inter alia the Chair of Hydrology and River Basin Management of the Technical Univeristy of Munich is involved. First results are estimated to be published in three or more years.

- Is there a map of floods/droughts risk?

Yes. The LfU provides a web-GIS application designating flood-prone areas for HQ_{100} and flood risk areas for $HQ_{frequent}$, HQ_{100} and $HQ_{extreme}$ (LfU, 2016a). Moreover, the flood information service provides gauge-based information on current water levels and discharges as well as notification stages in case a certain water level threshold has been exceeded.

- Whether an estimation of potential flood damage has been done?

No. Only estimates of monetary values per m^2 are available basend on the Basic European Assets Map (BEAM) (Geomer, 2012).

2.4 Water quality state, trends and monitoring

➢ Who performs monitoring of drinking water quality, which parameters are routinely observed and how frequent?

The health department is legally appointed to monitor the drinking water quality. Either the health department performs the analysis by itself, or the health department appoints either the water supplier or an accredited laboratory to perform the drinking water quality analysis. The water supplier has to inform the health department about the results of each analysis.

The TrwV seperates a *routine analysis* from a *comprehensive analysis*. The time interval of both analysis varies depending on the mean amount of water supplied a day (in m^3). E.g. the water quality of a water utility supplying between 10 m^3 and 1000 m^3 a day has to be controlled four times a year for the routine analysis and once a year for the comprehensive analysis. The differentiation between routine analysis and comprehensive analysis is not made if water utilities supply more than 100.000 m^3 on average a day. In this case the water quality has to be controlled ten times a year. Once the mean water supply increases of 25.000 m^3 one control per year has to be added and so on. In general, the greater the supply the more controls have to be performed per year.

According to the TrwV, different microbiological, chemical and indicator parameters have to be controlled with regard to threshold exceedings.

The following parameters are part of the *routine analysis* (thresholds are given in brackets):

ammonium (0,5 mg/l), **coliform bacteria** (0/100ml), **dyes** (0,5 m^{-1}), **odor** (3 TON), **taste** (acceptable for consumer), **colony count** at 22° and 36° (without anomalous changes), **electrical conductivity** (2790 µS at 25°), **turbidity** (1 NTU), **pH** (≥ 6,5 and ≤ 9,5)

only required if preparation and/or desinfection substances are added:
aluminium (0,2 mg/l), **iron** (0,2 mg/l)

only required if water is fully or partly extracted from surface waters:
clostridium perfringens (0/100ml)

The following parameters are part of the *comprehensive analysis* (thresholds are given in brackets):

Microbiological parameters:
escherichia coli (0/100 ml), **enterococci** (0/100 ml)

Chemical parameters, concentration can not increase in the supplying network:
acrylamide (0,0001 mg/l), **benzol** (0,001 mg/l), **boron** (1 mg/l), **bromate** (0,01 mg/l), **chromium** (0,05 mg/l), **cyanide** (0,05 mg/l), **1,2-dichloroethane** (0,003 mg/l), **fluoride** (1,5 mg/l), **nitrate** (50 mg/l), **active substances from pesticides and biocides** (0,0001 mg/l), **total active substances from pesticides and biocides** (0,0005 mg/l), **mercury** (0,001 mg/l), **selenium** (0,01 mg/l), **tetrachlorethylene and trichlorethylene** (0,01 mg/l), **uranium** (0,01 mg/l)

Chemical parameters, concentration can increase in the supplying network:

antimony (0,005 mg/l), **arsenic** (0,01 mg/l), **benzo(a)pyrene** (0,00001 mg/l), **lead** (0,01 mg/l), **cadmium** (0,003 mg/l), **epichlorohydrin** (0,0001 mg/l), **copper** (2 mg/l), **nickel** (0,02 mg/l), **nitrite** (0,5 mg/l), **PAH's** (0,0001 mg/l), **trihalomethanes** (0,05 mg/l), **vinyl chloride** (0,0005 mg/l)

Indicator parameters:
chloride (250 mg/l), **Clostridium perfringens** (0/100ml), **sodium** (200 mg/l), **manganese** (0,05 mg/l), **total organic carbon** (without anomalous changes), **oxidizability** (5 mg/l O_2), **sulphate** (250 mg/l), **calcite solubility** (5 mg/l $CaCO_3$)

- Who performs monitoring of drinking water resources (surface water, groundwater…) quality, which parameters are routinely observed and how frequent?

The EÜV regulates that the water supplier is obligated to perform a monitoring of the drinking water resources and the raw water in the DWPZ. Moreover, the water suppliers have to control the development in the catchment and the DWPZ. In this context, the water supplier has to inspect the compliance with restrictions and requirements in zone II at least every three months while an inspection of the fence and the labeling of zone I has to be done once a year. The BayWG obligates land owners to give access to their territories to the authorities in order to perform these controls.

The EÜV regulates the frequency and the parameters of the water quality monitoring. The monitoring is separated in a *short monitoring* and a *complete monitoring*. While a short monitoring has to be performed once a year, the frequency of a complete monitoring depends on the annual water supply of the facility. In case the annual water supply does not exceed a total amount of 10,000 m^3 a year, the complete monitoring has to be done once conspicuous changes in the raw water quality have been noticed. In contrast, a facility supplying more than 10,000 m^3 a year has to perform the complete monitoring every five years as well as in the following year of a short monitoring if conspicuous changes have been noticed, respectively. A short monitoring does not have to be performed in a year the complete monitoring is done.

The parameters of the *short monitoring* are the following:

color (visual inspection), **turbidity** (visual inspection), **odor** (qualitative inspection), **temperature**, **electrical conductivity**, **pH**, **solute oxygen**, **acid capacity pH 4.3**, **acid capacitiy pH 8.2** (if not determinable, **base capacitiy pH 8.2**), **calcium**, **magnesium**, **sodium**, **potassium**, **chloride**, **nitrate**, **sulphate**, **dissolved organic carbon** (DOC), **coliform bacteria**, **colony count** at 22° and 36° and **escherichia coli**

The additional parameters of the *complete monitoring* are:

manganese, **iron**, **aluminium**, **arsenic**, **ammonium**, **nitrite**, **phosphate**, **silica** and **spectral absorption coefficient** for 436 nm and 354 nm

Depending on the usage of different substances in the catchment area (based on information from users), an analysis of raw water quality has to be conducted in a 5-year cycle with regard to these substances. If no details are provided, the analysis has to be performed with regard to the following pesticides (if not excludable):

atrazine, **desethylatrazine**, **desisopropylatrazine**, **simazine**, **terbuthylazine**, **desethylterbuthylazine**, **bentazone**, **dichlorprop**, **diuron**, **isoproturon**, **metazachlor**

- Is there systematic monitoring of quality parameter trends for drinking water and for their resources? Who performs this monitoring?

Both, the drinking water as well as the raw water are monitored systematically. The monitoring is performed by the water supplier and by the WWA.

- Who is the user of this data?

  Basically, the WWA and the LfU are user of this data. Moreover, the data can be provided to research institutes for research purposes.

- Which is the procedure in the case of negative quality trends?

  According to the TrwV, the water supplier is obliagted to inform the health department and to take countermeasures in case of negative water quality trends in the raw water as well as in the drinking water. The authorities, as the legally appointed water supplier, are thus obligated to take countermeasures as well.

  Moreover, if harmful substances that are not included in the TrwV are detected in the raw and drinking water, both the water supplier and the authorities are obligated to counteract.

3.Actual land use activities

3.1 Land use map

Task 1. In this chapter, a **land use map** shall be outline on national level, each partner ***for eligible areas by the Programme Interreg Central Europe in their country***.

The map should include only areas of drinking water recharge areas. Drinking water recharge areas should be determined depending of national regulations for drinking water protection areas.

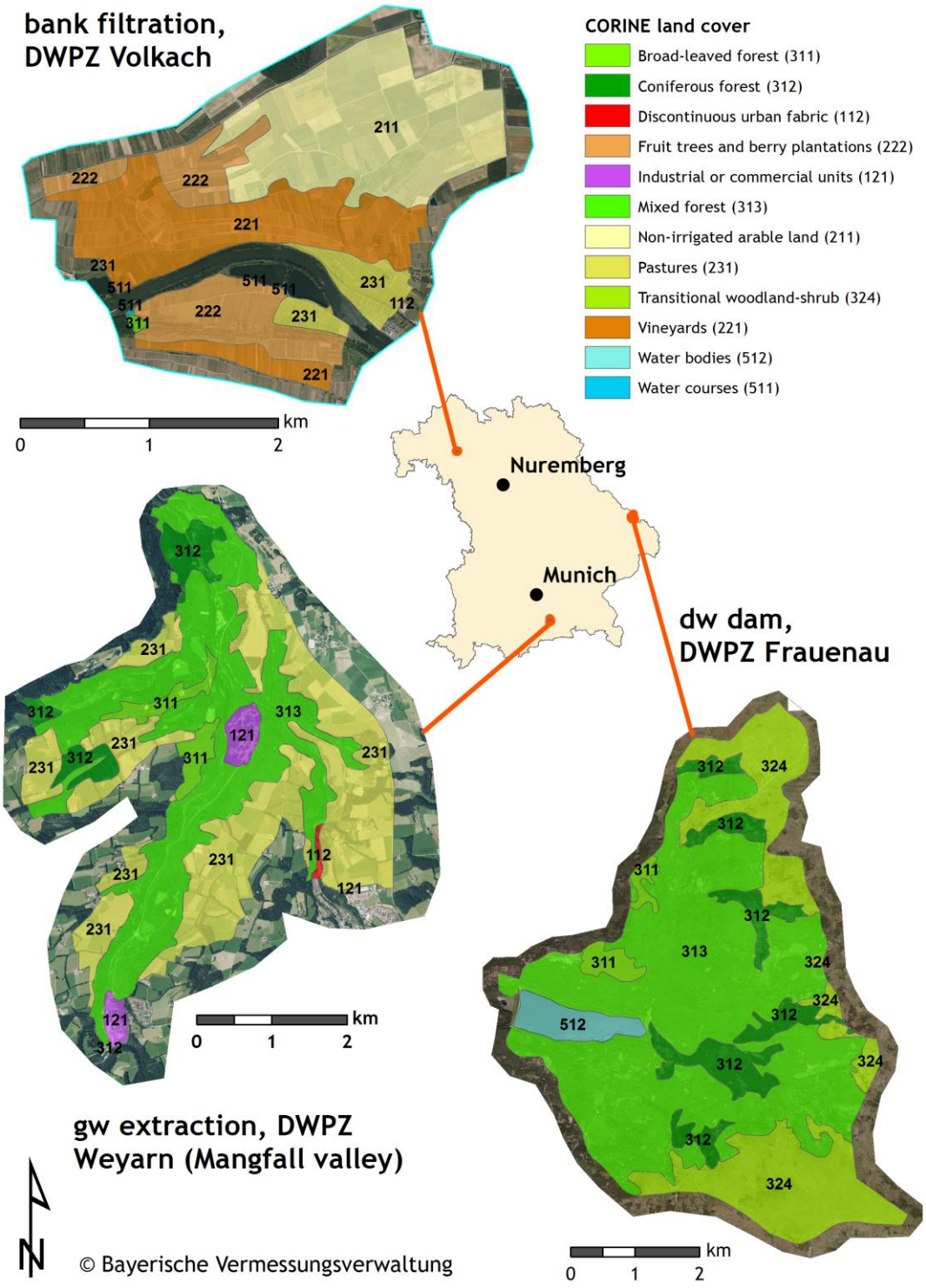

Figure 3 Examples of land use activities in DWPZ for bank filtration (Volkach), groundwater (gw) extraction (Weyarn, Mangfall valley) and drinking water (dw) dam (Frauenau) based on CORINE 2012 (BKG, 2016).

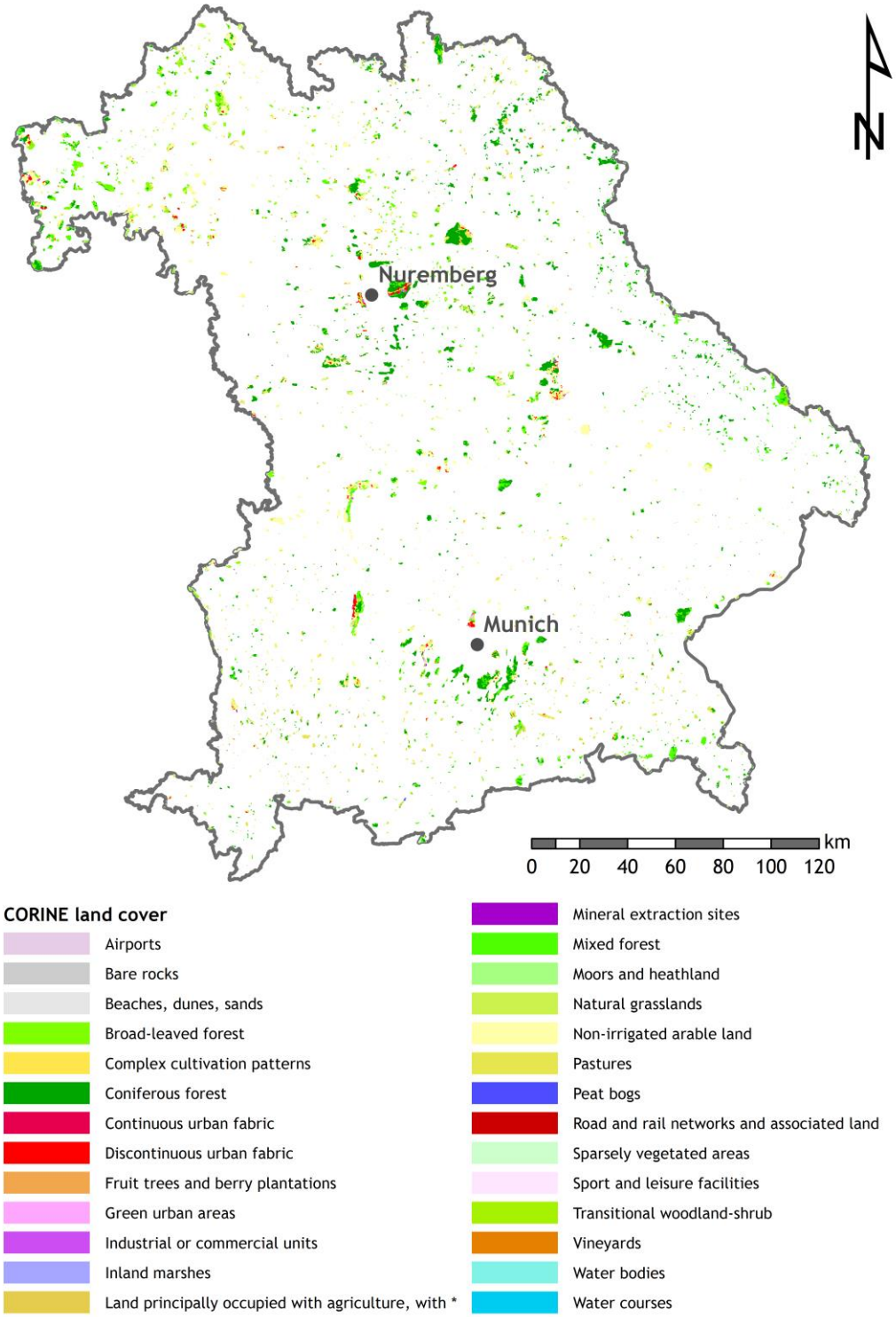

Figure 4 Land cover in all DWPZ in Bavaria based on CORINE 2012 (map resolution 600dpi) (BKG, 2016).

Task 2. Using **Corine land cover 2012 (please use LABEL 3 in legend)** fill the table with CLC code, category name, percentage ratios of particular land use areas and its surface area in km^2. The data consider areas of drinking water recharge areas.

CLC code	LABEL 3	Surface area (%)	Surface area (km^2)
111	Continuous urban fabric	0.04	28.78
112	Discontinuous urban fabric	5.28	3722.29
121	Industrial or commercial units	0.95	673.06
122	Road and rail networks and associated land	0.04	30.04
124	Airports	0.09	61.64
131	Mineral extraction sites	0.09	64.59
132	Dump sites	0.01	5.23
133	Construction sites	0.00	2.24
141	Green urban areas	0.11	75.85
142	Sport and leisure facilities	0.27	187.75
211	Non-irrigated arable land	33.39	23558.16
221	Vineyards	0.08	56.52
222	Fruit trees and berry plantations	0.20	140.18
231	Pastures	20.68	14587.80
242	Complex cultivation patterns	0.23	163.88
243	Land principally occupied with agriculture, with significant areas of natural vegetation	0.18	125.06
311	Broad-leaved forest	5.45	3846.40
312	Coniferous forest	20.52	14475.33
313	Mixed forest	9.33	6585.60

321	Natural grasslands	0.92	651.99
322	Moors and heathland	0.29	204.28
324	Transitional woodland-shrub	0.49	347.53
331	Beaches, dunes, sands	0.04	27.17
332	Bare rocks	0.16	109.97
333	Sparsely vegetated areas	0.10	67.38
335	Glaciers and perpetual snow	0.00	0.34
411	Inland marshes	0.02	17.18
412	Peat bogs	0.18	128.44
511	Water courses	0.20	144.22
512	Water bodies	0.65	459.36

3.2 Overview of the particular land use activities

The purpose of this chapter is to point out frequently land use activities and techniques that have impacts on the ecosystem function "water resources protection and protection against floods". The goal is to collect knowledge for different types of drinking water sources and land uses with regard to drinking water and flood management in drinking protection zones with best management practice in your country.

Please, describe all activities, structural and non-structral, good and bad management practices in drinking water recharge areas.

It is important to considered all drinking water types in your country (surface water, water from dams, alluvium groundwater, karst groundwater…) for each land use (for example, land use practice in agricultural lands in karst aquifer and in alluvium aquifer).

Please create a catalog of managemnet practices in your county and in T1.2.1 provide only best management practices for sustainable land use in drinking water recharge areas.

3.2.1 Urban areas

Task: To what extent is built sewer system at the state level (percentage rate). What type of wastewater treatment plants from households is used and in what percentage? In which way is waste management carried out in your country (domestic, industrial, medical ...)? In which way you manage floods/droughts?

Wastewater treatment

The public sewage system covers a channel length of about 100.000 km in Bavaria. 96% of the Bavarian population is connected to the public sewage system. Private sewers are estimated to be at least twice as long as the public sewage system. It can be assumed that 80% of the private sewage system is damaged which may harmful affect the environment (LfU, 2013a).

57% of the public sewage system are combined sewers while 43% are separated sewers. In general, wastewater treatment is organized in a decentralized manner; if ecological and economical aspects do not permit a connection to the public sewage system, smaller wastewater treatment plants can be installed for settlement structures with a population equivalent (p.e.) of < 2000 (following Art. 3 of the Council directive concerning urban wastewater treatment, the minimum requirement for these plants is similar to municipal wastewater treatment plants of size class 1).

In Bavaria, nearly 2700 urban water treatment plants are installed with a p.e. of 26,9 mio. With regard to p.e., the majority of the public is connected to *activated sludge plants with anaerobic sludge digestion* (12,53 mio p.e., 307 plants). Second are *multi-staged biological treatment plants* (7,95 mio p.e., 55 plants), followed by activated *sludge plants with aerobic sludge digestion* (4,22 mio p.e., 709 plants). The remaining treatment plants are as follows (decreasing order in terms of p.e.):

- trickling filter plants (0,87 mio p.e., 199 plants)
- sewage treatment ponds with biological treatment (0,4 mio p.e., 292 plants)
- aerated sewage treatment ponds (0,3 mio p.e., 196 plants)
- biological treatment plants in parallel operation (0,28 mio p.e., 15 plants)
- unaerated sewage treatment ponds (0,23 mio p.e., 683 plants)
- rotating biological contactor plants (0,12 mio p.e., 149 plants)
- substitutional sewage treatment ponds (0,02 mio p.e., 53 plants)
- constructed wetland (0,009 mio p.e., 46 plants)

During the last decades, a tendency towards a closure of small wastewater treatment plants can be observed due to a need of rehabilitation. The concerned settlements are thus more and more connected to large-scale treatment plants (LfU, 2010b).

Basically, the implementation of wastewater treatment plants as well as any kind of wastewater disposal is prohibited in zone I and II of DWPZ. Based on the EÜV and the valid (technical) guidelines the Bavarian State Office for Water Management (LfW, today LfU) published a technical guideline regulating the time intervals for technical inspections of sewage systems (LfW, 2003). In this guideline, hydrologically critical areas are clustered to ensure an adequate protection of sensitive areas. For example, karstic areas are grouped together with zone II of water protection zones meaning that these

areas require a similar maintenance. The guideline regulates that a detailed visual inspection of public sewage systems and property drainages has to be performed once a year while leakage tests have to conducted in a 5-year cycle. While the inspection of public sewer systems is systematically implemented, an inappropriate maintenance of private infrastructures may represent a source of contamination.

Waste management

The districts and cities without districts are responsible for the public waste management in Bavaria. This task can also be further delegated to municipalities located in each district if a regular waste management can be ensured. Similar to the water supply, municipal associations can be founded in order to jointly organize an adequate waste management.

In general, the principle of waste management is hierarchically structured:

1. prevention (the production of waste should be avoided as far as possible)
2. preparation for recycling
3. recycling
4. further utilization (e.g. for energy production)
5. disposal

Thus, the waste management integrates the principles of resources protection and sustainable recycling economy (LfU, 2013b).

In water protection zones, the deposition of waste is prohibited in all zones to avoid a diffuse contamination. Moreover, the implementation of waste treatment plants is prohibited in zone II. Special permits can be assigned for small waste treatment plants (as usual for agricultural or household purposes) in zone III of water protection zones (LfU, 2003).

Flood management

Bavarian flood management strategies are working towards a decentralized flood protection, e.g. decentralized rainwater drainage and natural water retention. In this context, desealing and green roofs are possible measures for urban areas becoming more and more established. Moreover, river restoration also represents a considerable measure for urban areas supporting the natural water retention capacity of the river (e.g. Isar, Munich).
Nevertheless, structural measures play an important role in urban flood management. Basically, measures are assessed for HQ_{100} events plus 15% to take possible climate changes into account (LfU, 2016b). Typical measures implemented in urban areas are dykes, dams as well as the sewage system. Moreover, sewerage storages are

implemented structural measures enabling a centralized retention without spilling of untreated water (München, 2016). In addition these measures are not visible in the urban landscape and thus contribute to the enhancement of the cityscape.
Further protection can be given by mobile elements requiring a planned and organized commitment of human resources.

Drought management
The need of drought management strategies became prominent in connection with climate change projections. In Bavaria, some adaption strategies for low water management have already been implemented, e.g. low water elevation through the transition system Danube river - Main river (WWA-Ansbach, 2014). In order to implement further drought management strategies, current projects are working on adaption strategies. In this context, a main focus is the reliability of drinking water supply.

3.2.2 Industrial areas

Task: What industrial branches are most widespread in your country? Which are the main pollutants that are product of their operation? Is there systematic monitoring of groundwater and surface water quality related to industrial operation? In what way is treated waste water from industrial facilities?

Manufacturing industries contribute most to the industrial sector in Bavaria. From an economic point of view, the manufacturing industries contribute 27,4% to the gross value-added in Bavaria. Further 25,9% is accounted for financing, leasing and corporate services, 20,1% for the trading, transport and hospitality sector and 19% for public and other services.
In terms of sales and number of employees, mechanical engineering productions and car and car parts production represent the strongest industries in Bavaria. As a product of their operations, different pollutants have to be removed from the waste water before it can be discharged into a water body or the public sewage system (StMWi, 2014).

Basically, pollutants resulting from mechanical engineering are heavy metals (e.g. copper, lead or zinc), washing and cleaning agents (e.g. phosphonates, adsorbable organic halogen compounds [AOX], polycarboxylates, ethylenediaminetetraacetic acid [EDTA]), oils and lipids or acids and lyes from pickling. Many of these substances, in particular agents of washing and cleaning products, are persistent and thus require special treatment procedures. Moreover, oils and lipids have to be removed before the waste water can be recycled as process water.

An important source of contamination in the automotive industry results from painting processes. The use of solvent-based paints can pose a risk for the environment and thus

sets requirements for industrial water treatment. Frequent solvents in paints are hydrocarbons such as toluenes and xylenes. In this context it is worth to note that the use of solvent-free powder paints is on the rise and was primarily used in the series production of BMW (GRUDEN, 2008). Further pollutants resulting from the production of cars and car parts are similar to the those emitted from the mechanical engineering industry. So, washing and cleaning agents, heavy metals and oils and lipids also represent typical water pollutants from the autmotive industry. Moreover, heavy metals also represent frequent pollutants from other main industries in Bavaria, e.g. electro industry.

The treatment of wastewater from industrial facilities has to be adapted to the specific requirements of each industrial sector since different branches emit different pollutants. The WHG regulates that private wastewater treatment plants have to correspond to state-of-the-art techniques. Moreover, the WHG regulates the conditions for which the construction, operation and modification of water treatment plants require authorizations. Basically, the requirements of sewage disposal and quality have to be met in terms of compliance with discharge threshold values.

The AbwV gives further requirements to reduce the discharge of pollutants from industrial sites. These requirements include water-saving techniques in the cleaning process, indirect cooling measures, the use of low-pollution operating materials as well as a process-integrated material recycling. Moreover, the AbwV integrates tables of limit values for various industrial sectors (e.g. metal processing industry) thus setting the frame of threshold values for branch-related sewage disposal.

3.2.3 Agricultural land

Task: Please provide information concerning the agricultural usage, e.g. most widespread crop cultivation, crop rotations, sowing technologies, fertilizers, etc. Also, please provide a map of spatial distribution of nitrogen and phosphorus in agricultural areas (if it is done on the national level). How you manage floods/droughts in agriculture areas?

Agriculture in Bavaria

Agricultural land covers a surface area of 3.15 mio ha in Bavaria. 34% of this area is used as permanent grassland, 65.6% is used as arable land and only small areas (ca. 0.4%) are used for further land uses, such as horticultures and christmas tree cultivation.

The largest share of surface area in arable lands is used for grain farming (1.17 mio ha; 37.3% of total agricultural land, 56.9% of arable land). The percentage distribution of crop types in grain farming is as follows:

- 46.6% wheat,
- 29.7% barley,
- 11.6% corn maize,
- 6.5% triticale,
- 3% rye,
- 2% oat,
- 0.3% summer mixed grains,
- 0.3% other grains

The second largest share of surface area in arable lands is used for plants harvested green (0.58 mio ha; 18.3% of total agricultural land, 27.9% of arable land). The percentage distribution of plants harvested green is as follows:

- 74% silage maize,
- 16.3% leguminous crops,
- 5.5% grains for whole plant harvest,
- 3.3% field grass,
- 0.9% other plants

Additionally, industrial crops (4,3%, 6,6% of arable land), root crops (2,9%, 4,4% or arable land), set-aside areas (1,5%, 2,3% of arable land), other arable land (1,3%, 2% of arable land) (LfStat, 2015c).

Water protection

Agricultural land is considered to be the main source for diffuse groundwater contamination. In order to reduce the leaching of nutrients (e.g. nitrate and phosphate) into the protected water bodies, several limitations and restrictions have been implemented in DWPZ. For example, limitations on using organic or synthetic fertilizers can be defined differently for each DWPZ while basically, the application of farm manure is prohibited in zone II of DWPZ due to its proximity to the water extraction plant (LfU, 2003). This interdiction may generate considerable conflicts between water management authorities and farmers farming livestock sustainably using the produced farm manure for the cultivation of fodder crops.

Legally implemented obligations to compensate economic losses from farmers resulting from limitations in land use (WHG) as well as state subsidy programmes, e.g. the cultural landscape programme (Kulturlandschaftsprogramm - KULAP), help to reduce the diffuse contamination of concerned water bodies. Moreover, voluntary cooperations between water suppliers and farmers are established to further reduce the input of fertilizers and land use intensification.

On average, 32% of the land surface in DWPZ is covered with arable land while 23% is covered with grassland in Bavaria. The following values are based on a data analysis of 12 different DWPZ provided by the LfU. Agricultural land use activities are regulated by voluntary cooperations between farmers and water suppliers in these DWPZ. Before the beginning of the cooperation, widespread crop cultivations in the considered DWPZ have been as follows (decreasing order of area percentage):

- winter wheat
- malting barley
- maize
- winter barley
- rape

The implementation of set-aside areas, catch crop cultivations and the conversion from arable land to grassland is fostered by state subsidy programmes as well as by voluntary cooperations with the farmers. Especially the conversion to grassland is considered to be promissing.

However, some districts in Bavaria still suffer from increased nitrate concentrations in the raw water according to LfU (2015). Especially in Lower Franconia, nitrate concentrations above the permitted threshold of 50 mg/l could be identified in 16,4 % of the extracted water amount. On average, the nitrate threshold exceeded in 3,4 % of the total water amount extracted for water supplying purposes in Bavaria in 2014.

While the EU failed to attach conditions of financial support primarily to greening activities making greening to the main target in agricultural policy, a more ecological-based implementation of EU agricultural policy on German and Bavarian level has not been done as well.

Flood management in agriculture

The WHG manifests limitations and restrictions for flood management on national level. So the conversion of grassland to arable land is prohibited on designated inundation sites. Moreover, the conversion of alluvial forests to other land use types is prohibited as well on these sites. Both measures are of vital importance for the retention of water as well as for the regulation of the flow velocity.

Moreover, the natural water retention represents an integral part of the Bavarian flood management programme '*Aktionsprogramm 2020plus*' (StMUV, 2014). As the primary part of the protection programme, natural retention is subdivided into measures close to the water body (e.g. dyke relocation, enhancing the linkage between the alluvial plain and the water body, river channel lengthening) and measures in the catchment (e.g. conversion of arable land to grassland, conservation tillage). While the Bavarian state is

responsible for maintenance works close to water bodies, the municipalities and the agriculture and forestry sector are responsible for the implementation of measures in the catchment. The water authorities consult and financially support the involved persons/parties to implement considered measures.

3.2.4 Forest

Task: Which forest species are most widespread in your country. Whether forests are used for water quality management and flood/droughts protection and in which way?

The Bavarian Forest Act (BayWaldG) defines that each forest in mountain sites, low mountain ranges, riparian strips and karstic areas serving to prevent flood events, inundations, rockfalls, landslides and other natural hazards represents a protection forest. Thus, the protective function of forests are recognized and considered in managing actions of the Bavarian State Forestry Office and supported by the Bavarian Forest Institute.

Moreover, the interests of nature conservation and water protection are integrated in the BayWaldG and have to be considered for each forest management task. In order to sustainably ensure the quality of drinking water from forest sites, the share of deciduous trees and firs should be increased continuously. These tree species foster diversity and stability of the forest stands which is of fundamental importance for drinking water protection. The Bavarian State Forestry Department pursues the long-term strategy to continously increase the amount of deciduous trees and firs in the state-owned forests in Bavaria. Therefore especially spruce pure stands should be converted (BaySF, 2015a). Due to their shallow root networks spruces are vulnerable to drought stress and windthrow and thus increase the overall vulnerability of the forest system (including its soils) to external stresses.

State-owned forests cover an area of 808,000 ha in Bavaria representing 11.4% of the state territory. However, state-owned forests represent only 30% of the total forest area. 56% of the total forest areas are privately owned, 12% corporate forests and 2% national forests. According to a statistical survey of the Bavarian State Forestry Department, the following tree species have been the most widespread in Bavaria in the financial year 2015 (1 July 2014 - 30 June 2015) (decreasing order of area percentage, black numbers are state-owned forests, blue numbers are total Bavarian forests):

- spruce (43%, 42%)
- beech (18%, 14%)
- pine (16%, 17%)
- other deciduous trees (11%, 15%)
- oak (6%, 7%)
- other coniferous trees (4%, 3%)
- fir (2%, 2%)

Focussing on DWPZ, 26.6% of the state-owned forests located in DWPZ have been covered with deciduous forest and firs in the considered period (2015). The 5-year-objective is to increase these area to > 30%. Moreover, 78,580 ha of the state-owned forest is located in DWPZ. This area size increased of 2,000 ha compared to 2014 (BaySF, 2015b). Further 25% of the state-owned forest are considered to have further water protection functions.

Since the beginning of the 1990's the Bavarian State Forestry Office operates a monitoring network of forest climate stations in selected forest catchments. This network has been linked to the monitoring network for mass fluxes into the groundwater in 1996 in order to implement a comprehensive forest monitoring network. The implementation and operation of this network has legally been strengthened by an administrative agreement between the Bavarian State Forestry Office and the Bavarian Water Authority (RASPE et al., 2008).

While a sustainable development of state-owned forests can be fostered by the government as well as by the 2,700 employees working for the Bavarian State Forestry Office, a sustainable development and continuous controls of privately owned forests are difficult to handle. Moreover, the ownership structure makes this process even more difficult since, on average, for each owner there is an area of 2 ha forest.

3.2.5 Pastures

Task: Which activities and techniques are used in livestock farming?

Since 1988 the Bavarian Ministry of Agriculture provides the cultural landscape programme (KULAP) giving advisory and financial support for sustainable and landscape preserving actions. Moreover, the Bavarian Ministry of the Environment provides a contract-based nature conservation programme (VNP) also supporting similar aspects. Different measures are prescribed with a fixed compensation payment per hectar of implemented measures. These programmes foster the conversion of arable land to grassland as well as the preservation of grassland on specific sites making grassland topics to a central theme of the Bavarian agricultural and environmental policy.

Grasslands cover more than one third of the land used for agricultural purposes in Bavaria. Already 34% of the agricultural land are permanent grasslands. The most frequent species groups on Bavarian grasslands are grasses (73%), herbs (20%) and leguminous plants (7%). In the following, the results of the Bavarian grassland monitoring from 2002 to 2008 serve as a base to describe the characteristic values of grassland use in Bavaria.

Basically, grasslands are used as pastures (73,7%), meadows (16,6%) and mountain pastures (6,7%) in Bavaria. As measured by the amount of cuts per year, 16% of grassland sites in Bavaria has been used extensively (between 1 and 2 cuts per year) while 17% have been used very intensively (≥ 4 cuts per year) (LfL, 2011).

To sustainably protect the ecosystem services of grasslands in DWPZ, grazing activities are prohibited in zone II. Further limitations of grazing activities are generally implemented for zone III to limit the extensive soil degradation through livestock trampling and to sustain the turf qualities and the physical properties of the soil system (LfU, 2003). Moreover, to use the water retention capacity of grasslands their preservation is also integrated in the WHG. Thus, the conversion of grassland to arable land is prohibited on riparian strips and inundation areas.

However, a tendeny of grassland losses (-5% from 2003-2012) could be observed during the last decade (BfN, 2014). This tendency can further increase since future land use conflicts in DWPZ may arise from the adapted definition of permanent grasslands. Following the announcement of the European Court of Justice (ECJ) a permanent grassland is an *'agricultural land which is currently, and has been for five years or more, used to grow grass and other herbaceous forage, even though that land has been ploughed up and seeded with another variety of herbaceous forage other than that which was previously grown on it during that period'* (ECJ, 2014). This definition has been introduced by the ECJ as a result of a legal dispute of a German farmer who considered reseeding actions on his grassland sites would break the five-years regulation so that he keeps the status *'arable land'* for these sites. Generally, farmers try to avoid the status of permanent grasslands due to a lower sales value and the ban on plowing. Thus, the implementation of ecologically valuable permanent grasslands is difficult since the economic value of arable land sites and permanent grasslands as well as the legal restrictions on both land use entities mostly are of top priority. Moreover, a plowing up of grasslands can release great amounts of nutrients which can be leached into protected water bodies and thus pose a threat to the water quality.

3.2.6 Transport units

Task: In which way do you manage waste water from roads? In which way do you prevent freezing on the roads during the winter period? Are there any other activities related to management of transpore units that could have negative impact on water quality?

Road maintenance tasks are performed by the public authorities. In this context, the responsability of a public authority depends on the road types, e.g. the municpalities are

responsible for the maintenance of country roads. The maintenance tasks comprise the road drainage, road cleaning and the care of green areas along the roads. Moreover, the public authorities are responsible for winter services (snowplow, de-icing salt) and road lighting in built-up areas. These tasks can be further delegated to private companies or to citizens.

Basically, seepage of rainwater represents a usage of water and thus has to be permitted by law. However, the Bavarian ministry of the environment implemented an exemption regulation for the seepage of rainwater regulating that specific seepage actions do not require an official permission by the responsible public authority. To be exempted from permissions, specific requirements of the technical guidelines legislated by the ministry (Technische Regeln zum schadlose Einleiten von gesammeltem Niederschlagswasser in das Grundwasser - TRENGW) have to be met. An important requirement is to ensure an extensive seepage through overgrown topsoils. The exemption regulation is not valid for any kind of seepage measures in water protection zones.

In 2005, the Supreme Building Authority of the Bavarian State Ministry of the Interior implemented a revised ordinance for the creation of roads and road drainage (Richtlinie für die Anlage von Straßen, Teil Entwässerung - RAS-Ew). The updated version of this ordinance integrates the concerns of water protection and nature conservation thus setting enhanced requirements for road drainage systems. The ordinance further gives a basis for the planning, assessment and implementation of drainage systems. Moreover, the ordinance refers to state-of-the-art guidelines published from the German Association for Water, Wastewater and Waste (DWA). These technical guidelines give practical references for the assessment of rainwater retention basins (DWA, 2013), the planning, construction and operation of features for the seepage of rainwater (DWA, 2005) and recommendations for handling rainwater (DWA, 2007). Moreover, the ordinance for structural measures on roads in water protection zones (Richtlinien für bautechnische Maßnahmen an Straßen in Wasserschutzgebieten - RiStWag) sets specific requirements for road drainage in water protection zones. Thus, drainage systems have to be adapted to the protective effect of the groundwater cover, the protection requirements of the related water protection zone and the traffic volume.

Different drainage systems exist for road drainage within or outside built-up areas. While drainage ditches and basins are typical measures implemented outside built-up areas, drainage channels are frequently used drainage systems in built-up areas since adjacent buildings often do not allow an implementation of open drainage systems (e.g. ditches and basins). However, open drainage systems have to be prefered as far as possible.

Further risks for water quality can arise out of the restructuring or demolition of outdated transport-related structures, e.g. bridges. In this context, especially the demolition requires a particular attention since water pollutants, such as red lead used for corrosion resistance, can be leached and enter the water body. Moreover, requirements have to be set for temporary storages for demolition materials to preserve a diffuse contamination of the concerned water body.

A further source of risk results from the maintenance of water on transport unit construction sites and the reinjection of process water assuming specific requirements for the water treatment. In

this context, further requirements can be set for the management of reinjection acitivities e.g. if a rise of water from underlying (protected) aquifer layers has to be avoided.

3.3 Impact of land use activities on water quality and *quantity* floods/droughts - DPSIR approach for the present/past state - *prioritize national issues in DPSIR*

Task: Please use DSPIR method for the most important Drivers, Pressures, States (ecosystem services), Impacts, Responses (measures) that involves analyzing the pressures and impacts of human activity on the quality and quantity of water resources and flood/drought risks in your country. Detailed description of the method is given at http://ia2dec.pbe.eea.europa.eu/knowledge_base/Frameworks/doc101182 Data should be given in the table like in example below.

Impact on water resources quality				
URBAN AREAS				
Driving forces	**Pressures**	**State (ECOSYSTEM SERVICES)**	**Impacts**	**Responses (MEASURES)**
insufficient dimensioning of sewage systems	discharge of contaminants during flood events	high pollutant compounds in the water bodies	deterioration of surface and groundwater quality	reassessment of sewage systems, fostering implementation of seperated sewers
damaged private sewers	leakage of wastewater contaminants	increasing compounds of wastewater pollutants in groundwaters	deterioration of groundwater quality	fostering legal implementation of public controls and renovation activities
sealed surfaces	discharge of surface contaminants	increased pollutant concentrations in the environment	deterioration of surface water quality	implementation of desealing measures
centralized rainwater infiltration	limited drainage capacity	increased amounts of polluted sewer waters in combined sewers	contamination of surface waters and groundwaters in case of overflowing sewers	implementation of decentralized rainwater infiltration, e.g. desealing measures
AGRICULTURE				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
use of fertilizers (N	diffuse N	values of nitrates	deterioration of	implementation

consumption)	contribution (runoff and percolation)	above legally permitted limit values in some areas	groundwater quality, impact on human health	of appropriate measures, for example, ecological agriculture
open croplands between main crops	nutrient leaching through mineralisation of harvest residues; erosion and soil degradtion processes	growing trends of nitrate concentrations; solute transport to receiving waters	deterioration of groundwater quality, impact on human health; surface water eutrophication	implementation of catch crops
conventional soil tillage	nutrient leaching (especially through runoff); reduced humus content	increased nutrient concentrations in receiving waters (e.g. nitrate); reduced water purification	deterioration of water quality, impact on human health, surface water eutrophication	fostering conservation tillage, non-turning techniques
harvesting perpendicular to the slope	preferential flow paths and erosion, increased solute transport to receiving waters	increased nutrient and herbicide concentrations in receiving waters; less purification	deterioration of surface and groundwater quality	implemantation of legal restrictions fostering harvesting parallel to the slope
FORESTS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
N assimilation from atmosphere	N saturation of forest ecosystems and diffuse N discharge	increasing values of nitrate in the groundwater	deterioration of groundwater quality, impact on human health	implemenation of measures to increase N consumption, e.g. mixed forests
clear cuttings and deforestation	nutrient leaching due to less uptake by trees	increased nutrient concentrations in receiving waters (e.g. nitrate); reduced water purification	deterioration of groundwater quality, impact on human health	implementation of legal restrictions to avoid clear-cuttings also beyond the borders of DWPZ
harvesting with heavy machinery	soil compaction and deterioration of soil structure	decreased purification and reduced physico-chemical bonding of nutrients	deterioration of water quality	Implementation of a resource-friendly exploitation system
removal of deadwood	reduced formation of humus	decreased water purification	increased leaching of free nutrients and air pollutants	fostering an adequate deadwood management
coniferous	low quality of litter	decreased water	deterioration of	fostering a

monocultures	layer	purification	groundwater quality	conversion to mixed forests
missing understorey vegetation	one single storey crown	reduced filtering effects of vegetation cover	increased input of air pollutants into the ecosystem and particle detaching through splash-effects	implementation of adequate measure, e.g. natural regeneration
PASTURES				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
use of fertilizers	diffuse nutrient discharge (runoff and percolation)	increasing concentrations of nutrients (e.g. nitrate) in groundwater	deterioration of groundwater quality, impact on human health	implementation of appropriate measures, for example, ecological agriculture
plowing up of grassland	diffuse N contribution (runoff and percolation)	growing trends of nitrate concentrations	deterioration of groundwater quality, impact on human health	implementation of measures for advisory and financial support to avoid conversion of grassland
intensive use of heavy machinery on grasslands	soil compaction and deterioration of the turf and the topsoil structure	decreased water quality regulation and increasing amounts of nutrients in receiving waters	deterioration of water quality	extensification of land use activities on grasslands
intensive grazing activities	soil compaction and deterioration of the turf and the topsoil structure	decreased water quality regulation and increasing amounts of nutrients in receiving waters	deterioration of water quality	implementation of adapted grazing strategies
TRANSPORT UNITS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
sealed surfaces	discharge of surface contaminants	increased pollutant concentrations in the environment	deterioration of surface water quality, impact on human health	implementation of extensive seepage measures with overgrown topsoils
demolition of structural facilities	release of pollutants (e.g. red lead from bridges)	increased pollutant concentrations in the environment	deterioration of water quality, impact on human health	implementation of adapted demolition and restructuring strategies

INDUSTRIAL AREAS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
insufficient dimensioning of sewage systems	discharge of contaminants during flood events	high pollutant compounds in the water bodies	deterioration of surface and groundwater quality, impact on human health	reassessment of sewage systems, fostering implementation of seperated sewers
sealed surfaces	discharge of surface contaminants	increased pollutant concentrations in the environment	deterioration of surface water quality, impact on human health	implementation of desealing measures
centralized rainwater infiltration	limited drainage capacity	increased amounts of polluted sewer waters in combined sewers	contamination of receiving waters in case of overflowing sewers	implementation of decentralized rainwater infiltration, e.g. desealing measures
old industrial locations	soils contaminated with industrial sector-specific pollutants	contamination of groundwater	deterioration of groundwater quality, impact on human health	more stringent persecution of contaminated site remediation

Impact on water resources quantity				
URBAN AREAS				
Driving forces	**Pressures**	**State (ECOSYSTEM SERVICES)**	**Impacts**	**Responses (MEASURES)**
sealed surfaces	decreased infiltration capacity	decreased water recharge	decreased water quantity	implementation of decentralized infiltration measures, e.g. desealing
centralized rainwater infiltration	decreased infiltration capacity	decreased water recharge	decreased water quantity	implementation of decentralized infiltration measures, e.g. desealing
AGRICULTURE				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
conventional soil tillage	soil compaction and increased interflow and surface runoff	decreased groundwater recharge	decreased water availability and provision for supplying purposes	fostering conservation tillage, non-turning techniques

open croplands between main crops	surface sealing through aggregate destabilization and particle transport	decreased infiltration capacity and groundwater recharge	decreased water availability and provision for supplying purposes	implementation of catch crops
FORESTS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
harvesting with heavy machinery	soil compaction and deterioration of soil structure	decreased infiltration capacity and water recharge	decreased water availability and provision for supplying purposes	implementation of a resource-friendly exploitation system
coniferous monocultures	high water storage capacity of the trees and year-round interception; shallow root network	decreased groundwater recharge	decreased water availability and provision for supplying purposes	fostering a conversion to mixed forests
PASTURES				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
plowing up of grassland	deterioration of vertical connectivity and increased surface runoff	decreased groundwater recharge	decreased water availability and provision for supplying purposes	implementation of measures for advisory and financial support to avoid conversion of grassland
intensive use of heavy machinery on grasslands	soil compaction and deterioration of the turf and the vertical connectivity	decreased groundwater recharge	decreased water availability and provision for supplying purposes	extensification of land use activities on grasslands
intensive grazing activities	soil compaction and deterioration of the turf and the vertical connectivity	decreased groundwater recharge	decreased water availability and provision for supplying purposes	implementation of adapted grazing strategies
TRANSPORT UNITS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
sealed surfaces	decreased infiltration capacity	decreased water recharge	decreased water quantity	implementation of extensive seepage measures with overgrown topsoils
INSUTRIAL AREAS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**

sealed surfaces	decreased infiltration capacity	decreased water recharge	decreased water availability and provision for supplying purposes	implementation of decentralized infiltration measures, e.g. desealing
centralized rainwater infiltration	decreased infiltration capacity	decreased water recharge	decreased water availability and provision for supplying purposes	implementation of decentralized infiltration measures, e.g. desealing

Impact on floods/droughts				
URBAN AREAS				
Driving forces	**Pressures**	**State (ECOSYSTEM SERVICES)**	**Impacts**	**Responses (MEASURES)**
sealed surfaces	decreased infiltration capacity	decreased water retention	deterioration of non-structural flood protection	implementation of retention measures, e.g. desealing, green roofs or sewerage storages
centralized rainwater infiltration	increased discharge in sewer systems	decreased water retention	deterioration of non-structural flood protection	implementation of decentralized infiltration measures, e.g. desealing, green roofs or sewerage storages
insufficient dimensioning of sewer systems	limited drainage capacity	decreased water retention	increased risk for flash floods (overflow through exceeded drainage capacity) and river floods (backflow through increased river water level and impounded sewer water)	reassessment of sewer systems, fostering implementation of seperated sewers
river channelization	increased flow velocity and limited space	decreased river retention capacity	increased risk of flood damages during channel overflow	fostering river restoration
AGRICULTURE				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
open croplands	surface sealing	decreased	enhanced overland	implementation

between main crops	through aggregate destabilization and particle transport	infiltration capacity and water retention	flow contirbution to direct runoff	of catch crops
conventional soil tillage	soil compaction	decreased infiltration capacity and water retention	enhanced overland flow contribution to direct runoff	fostering conservation tillage, non-turning techniques
harvesting perpendicular to the slope	preferential flow paths and erosion, increased overland flow	decreased water retention on the field	enhanced overland flow contribution to direct runoff and sealing of structural measures (e.g. sewer systems)	implemantation of legal restrictions fostering harvesting parallel to the slope
FORESTS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
clear cuttings and deforestation	decreased interception and evapotranspiration lossed	reduced protection due to lower water retention	enhanced overlandflow contribution to direct runoff	implementation of legal restrictions to avoid clear-cuttings also beyond the borders of DWPZ
harvesting with heavy machinery	soil compaction and deterioration of soil structure	decreased infiltration capacity and water retention	enhanced overlandflow contribution to direct runoff	implementation of a resource-friendly exploitation system
removal of deadwood	reduced formation of humus and alteration of the surface structure	decreased water retention	enhanced probability of overlandflow contributions to direct runoff	fostering an adequate deadwood management
missing understorey vegetation	one single storey crown	less water retention due to less interception losses	enhanced probability of surface runoff	implementation of adequate measure, e.g. natural regeneration
PASTURES				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
intensive use of heavy machinery on grasslands	soil compaction and deterioration of the turf and the vertical connectivity	decreased water retention due to decreased infiltration capacity	enhanced overland flow contribution to direct runoff	extensification of land use activities on grasslands
intensive grazing activities	soil compaction and deterioration	decreased water retention due to	enhanced overland flow contribution	implementation of adapted

	of the turf and the vertical connectivity	decreased infiltration capacity	to direct runoff	grazing strategies
plowing up of grassland	deterioration of soil structure and vertical connectivity	decreased water retention	enhanced overland flow contribution to direct runoff	implementation of measures for advisory and financial support to avoid conversion of grassland
TRANSPORT UNITS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
sealed surfaces	decreased infiltration capacity	decreased water retention	deterioration of non-structural flood protection	implementation of extensive seepage measures with overgrown topsoils
INDUSTRIAL AREAS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
sealed surfaces	decreased infiltration capacity	decreased water retention	deterioration of non-structural flood protection	implementation of retention measures, e.g. desealing or green roofs
centralized rainwater infiltration	increased discharge in sewer systems	decreased water retention	deterioration of non-structural flood protection	implementation of decentralized infiltration measures, e.g. desealing, green roofs or sewerage storages
insufficient dimensioning of sewer systems	limited drainage capacity	decreased water retention	increased risk for flash floods (overflow through exceeded drainage capacity) and river floods (backflow through increased river water level and impounded sewer water)	reassessment of sewer systems, fostering implementation of seperated sewers
river channelization	increased flow velocity and limited space	decreased river retention capacity	increased risk of flood damages during channel overflow	fostering river restoration

4.SWOT analysis and evaluation of gaps

Task: Please do SWOT analysis and evaluation of gaps of actual land use activities and their relation to water management and flood management, focusing on the ecosystem services "protection of the water resources and protection against floods.

Link each remark regarding to strength, weakness, opportunity and threat also to identified measures, please provide short description of current situation for each measure (has some strategy developed? has the measure begun? Is it necessary to do anything? Is the state predicted budget for a changes?...)

- **STRENGTHS**
  - examples for good cooperations between farmers and water suppliers to enhance the drinking water protection in and beyond the borders of DWPZ
  - maintenance of public sewage systems in karstic areas is performed similar to activities in zone II of DWPZ
  - advisory and financial support for farmers (e.g. KULAP) for the implementation of adequate land use measures
  - legally implemented financial compensations for burdens resulting from official requirements in DWPZ and support by state offices for concerned farmers and foresters
  - considering the protective

- **WEAKNESSES**
  - not sufficient erosion protection measures enhance the risk of flood damages and surface water pollution
    - ➢ fostering the awareness of farmers and stricter legislations to reduce the risks resulting from erosion
  - attaching conditions of financial support *primarily* to greening activities has neither been succesfully implemented in EU agricultural policy nor in German or Bavarian agricultural policy
    - ➢ more consequent and ecological-based agricultural policy on EU, German and Bavarian level
  - no financial support from state programmes (e.g. KULAP) in

function of aquifer protection layers in the planning process of DWPZ
- formation of joint water boards to ensure a drinking water supply in remote areas and areas with possible water scarcity in the future
- development of supplying networks from different drinking water production areas to ensure a continuous water supply with clean drinking water
- implementation of an ordinance for erosion protection regulating management strategies for areas vulnerable to erosion
- legal regulations to maintain grasslands and their water retention function on riparian strips and inundation areas
- ensuring minimum ecological flow through transition systems in vulnerable areas (e.g. transition system Danube river - Main river

DWPZ
- supporting programmes for implementation of resources-friendly measures, such as KULAP, are regulated by StMELF, StMUV does not support land use measures
  - ➢ problem that water and agricultural management are distributed to two ministries
- mistrust between different stakeholders and the related stucked relationship between the different parties
  - ➢ lack of communication
- lack of public involvement already during the preparation of spatial planning and land management procedures

- **OPPORTUNITIES**
  - foster further advisory support for farmers to increase their awareness to drinking water and flood protection
  - increase the number of

- **THREATS**
  - estimated percentage of damaged private sewers and differing maintenance responsibility regulations of the municipalities
  - losses of grasslands during the last

cooperations between water suppliers and farmers ○ as far as possible, existing DWPZ should be extented considering the protective function of aquifer protective layers ○ attaching conditions of financial support primarily to greening activities ○ further restrictions and more precise limitations on using fertilizers and pesticides in and beyond the borders of DWPZ ○ increase the number and space of set-aside areas in agriculture ○ fostering the conversion of arable land to grassland ○ fostering conversion from forest monocultures to mixed forests ○ increase the amount of decentralized rainwater infiltration and retention (desealing, green roofs) ○ ensuring minimum ecological flow in drought-endangered river basins ○ fostering awareness of humans to flood risks to increase the individual protection of humans and belongings ○ reducing losses from water utilities	decade ○ ECJ definition of permanent grassland leads to further grassland losses, also in DWPZ ○ increasing intensification of farming activities ○ inadequate management of privately-owned forests and control difficulties arising from fragmented estates ○ unknown sources of water pollution from (unremediated) contaminated sites ○ further hardening of the stakeholder contests (especially farmers and water suppliers)

According to the German country report on the progress in implementation of the WFD programmes of measures (WRC PLC, 2015), all basic measures (11.3.a and 11.3.b - l) are completely implemented on the national level. In Bavaria, water abstraction has been identified to be a particular pressure in the Danube river basin district where basic measures are not sufficient to tackle the pressure.

In respect of relevant measures for PROLINE-CE, the identified key type measures in Germany are:

KTM2 (Reduce nutrient pollution in agriculture beyond the requirements of the Nitrate directive):

> from 1000 projects/measures, 156 have been completer, 444 are on-going and 400 have not yet started

KTM6 (Improving hydromorphological conditions of water bodies other than longitudinal continuity):

> 80 projects have been completed, for 90 construction is on-going, for 484 planning is on-going and 346 have not yet started

KTM12 (Advisory services for agriculture):

> in terms of number of advisory services, 68 have been completed, 752 are on-going and 79 have not yet started

KTM14 (Research improvement of knowledge base reducing uncertainty):

> in terms of number of research studies, development and demonstration projects, 227 have been completed, 487 are on-going and 186 have not yet started

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