PROLINE-CE

WORKPACKAGE T1, ACTIVITY T1.1

PEER REVIEW OF LAND USE AND WATER MANAGEMENT PRACTICES

D.T1.1.1 Country Reports About the Implementation of Sustainable Land Use in Drinking Water Recharge Areas

AUSTRIA

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Contents

1. Introduction

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

In Austria drinking water is gained mainly from groundwater (porous, karst/fissured, deep groundwater). Due to favourable climatic and hydrological conditions only about 2.3 % of the agricultural areas has to be irrigated and only 3 % of the overall available water resources is used in Austria.

Almost half of the total Austrian area is covered by forests. The dominant tree species is Norway spruce. Potential problems within Drinking Water Protections Zones (DWPZ) can occur through clear cut application and non-environmentally friendly harvesting methods. Additionally damages on trees through high wild ungulate densities are wide-spread in Austria and thus endanger the stability of the forests.

More than 30 % of the territory is used for agriculture, whereby 20 % of it is cultivated with organic methods. Grain growing is the dominant agricultural use within almost all river basins in Austria. Pollution of groundwater through nitrate loads and excesses of pesticides occur mainly within intensively used agricultural areas and regions with less precipitation.

Livestock farming is also a prominent land-use type in Austria. Contaminations of source waters can be caused by grazing and application of liquid manure near DWPZ.

Further impacts to groundwater bodies can occur through stone quarries and gravel pits within DWPZ, contaminated sites and tourist exploitation, especially ski-tourism.

Due to the “Federal State” structure of Austria regulations concerning DWPZ are different between the “Provinces” and legislative restrictions are often quite weak and even have no binding character in some cases.

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?

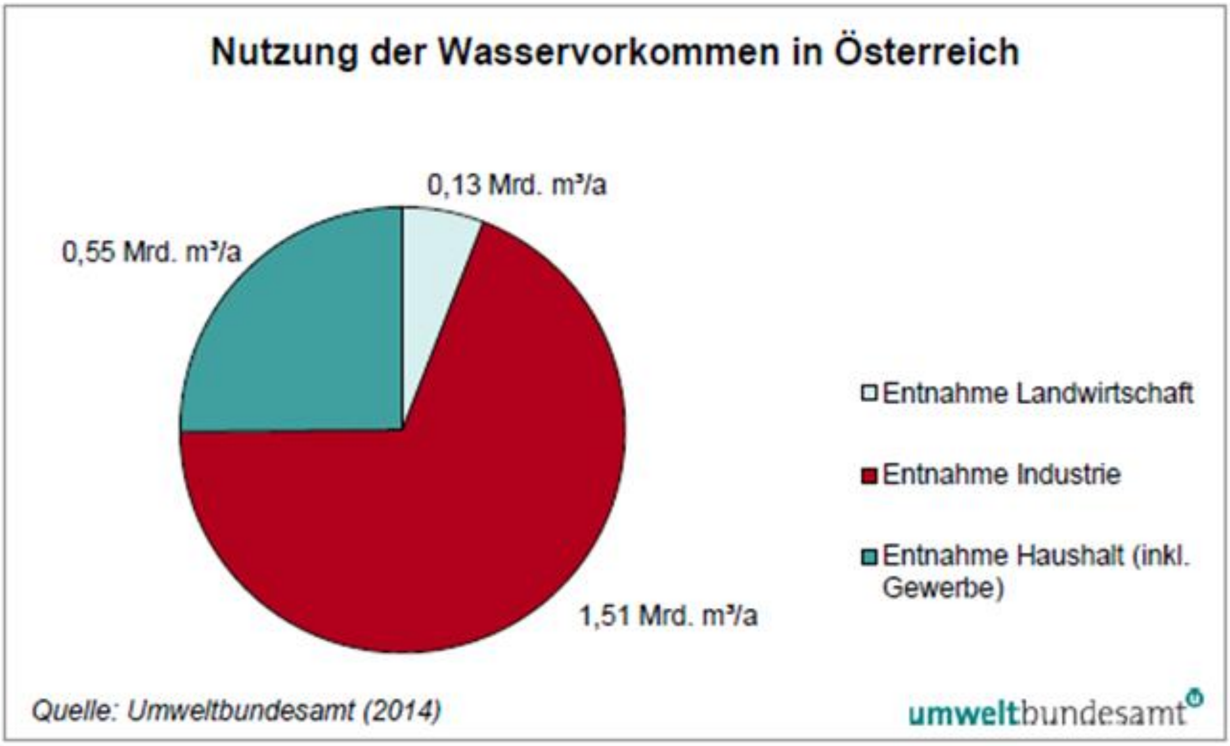
  Almost 99 % of the Austrian drinking water and also most of the industrial and agricultural water is being gained from groundwater. Only 3 % of the overall available water resources are used in Austria. Therefore Austria has in general no quantitative problems, except eventually in the future in some areas due to increased temperatures. Those may occur only in some specific regions, like e.g. in the case of the near-surface groundwater body “Seewinkel” in Burgenland and deep groundwater bodies “Steirisches and Pannonisches Becken” as well as “Oststeirisches Becken” in Styria and some regions in Carinthia).

- For which purpose is this water used?

69 % of the Austrian water demand (annual 2.18 billion m^3) are used by the industry (1.51 billion m^3), 6 % by agriculture and 25 % are used by households.

These values are based on well-secured Austrian-wide estimates. Concrete data about actual water withdrawal are not available until now, but are foreseen in the near future.

Figure 1: Water use in Austria due to different sectors (industry, household, agriculture)



- Who controls and manages water policy?

The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW - Water department): every 6 years the National Water Management Plan ("Nationaler Gewässerbewirtschaftungsplan") is conducted. Based on a status analysis the significant use of water and conservation and restoration measures are being defined and published in these plans.

- Who controls and manages drinking water policy?

Management: BMLFUW (approval of Water Management Frameworks – "Wasserwirtschaftliche Rahmenpläne"), provincial governments (regional legislation), water cooperative societies ("Wassergenossenschaften"), water associations ("Wasserverbände"), district authorities

Control: BMLFUW, State governor / district authority; regulated in the Water Status Monitoring Regulation („Gewässerzustandsüberwachungsverordnung")
For water supervision („Gewässeraufsicht") the Federal States are responsible
(see chapter „Industrial areas").

- The legal and administrative organization of water policy?

  The Austrian Water Law was designed by the BMLFUW to guarantee continuous provision of water as well as a safeguard for future water supply. Therefore it regulates the use of water, respectively the authorisation of the use of water, the protection of water resources and protection against floods and common water management obligations.

- The legal and administrative organization of drinking water policy?

  Austrian Federal Water Act

  Food Safety and Consumer Protection Act – Austrian Ministry of Health (BMG)

  Drinking Water Decree – BMG

  Austrian Food Codex – BMG

  Drinking Water Protection Areas (Water protection and water conservation areas – province authorities; “Wasserwirtschaftliche Rahmenpläne” / General Water Management Frameworks – approved by BMLFUW) – State and District Authorities

  Strategy concepts for drinking water supply and Drinking Water Plans in each Federal State

- Who manages and coordinates the implementation of state policy in scope of water?

  BMLFUW (Water Department)

- 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)

  See above and:

  Water Supply law for municipalities
  Water Supply Connection law for Federal States (except Tyrol – supply directly managed by the communities and water associations)
  Austrian Spatial Development Concept
  Spatial Planning Acts (for each Federal State)
  Austrian Federal Forest Law
  Austrian Federal Agriculture Act
  Austrian Agro-Environmental Programme (ÖPUL)
  Nitrate Action Plan
  Quality Objective Ordinance – Chemical Status of Groundwater
  Quality Objective Ordinance – Ecological Status of Surface Waters
  Quality Objective Ordinance – Chemical Status of Surface Waters
  Water Condition Monitoring Regulation (“Gewässerzustandsüberwachungs-VO”)
  Ordinances on Wastewater emissions – several fields
  Hydraulic Engineering Assistance Act (“Bundeswasserbautenförderungsgesetz“)

[more details see „CC-WARE: WP 4 (act. 4.1) and WP 5 (act. 5.1) Joint Report]

2.2. Drinking water protection zones

- Which are the criteria for determining water protection zones?

  Defined in the Austrian Water Act – the responsible authority (Ministry, State governor or district authority) can regulate the land-use or prohibit the construction of problematic facilities within these areas. Projects affecting the water household or the groundwater in quality or quantity can be prohibited in order to ensure a sustainable drinking water supply

  Additionally several guideline catalogues (like the "Guideline ÖVGW") are existing, but not mandatory.

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

  The responsible authority (Ministry, State governor or district authority) can regulate the land-use or prohibit the construction of problematic facilities or projects within these areas. – see above!

- Who controls and manages legal acts for determination of drinking water protection zones?
  The province authorities can issue a decree for Drinking Water Protection Zones (DWPZ) and are responsible for the implementation of the relevant measures – therefore the realization differs in the different regions and in every legally decreed DWPZ.

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

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

    First of all within potential DWPZ hydrological investigations and hydro-geological investigations are conducted. After a permit according to the Austrian Federal Water Act the respective protection zone is delineated in the "Wasserbuch" (= land register including all relevant water related issues).

    DWPZ are considered by the municipalities through the delineation within the respective spatial plans (land use plan etc.).

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

DWPZ are discussed with the respective land owners within the DWPZ and the relevant Water Authorities.

- Are borders of DWPZ negotiated and agreed?

Yes

- Are interdictions, limitations and measures negotiated?

Yes, interdictions and limitations are part of the negotiation and are compensated.

- Is there any coordination during this process?

Water suppliers are obliged to submit all necessary documents and to negotiate with the respective land owners (including relevant compensation). Afterwards the negotiation with the Water Authority is conducted.

- To what extent should boundaries of DWPZ, which were proposed based on investigations, be accepted (or can they be changed to some extent after their proposal) and what is the procedure for accepting proposed DWPZ?

The borders are negotiated with the land owners; hence they have to accept the borders which are outlined through this process.

DWPZ are classified into two different protection zones – 1 and 2. The protection zone 1 (immediate surrounding) has to be protected with fences, whereas the enlarged protection zone 2 has to be marked by means of information boards. By means of an approval due to the Water Law the affected land owner is informed about the relevant boundaries and limitations etc. In case of infringement a notification at the district administration ("Bezirksverwaltungsbehörde") is reported. The relevant land owner will be penalized due to the Water Law.

In some cases boundaries of DWPZ can be changed also after their approval due to new circumstances (new hydrological survey, land use changes, changes of the course of streams etc.). In these cases the Water Authority asks the relevant water supplier to define the new boundaries of the respective DWPZ and the procedure for approval starts again.

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

See above!

They are considered according to the basic data stemming from hydro-geologists and hydrologists and the subsequent negotiations with the land owners. The water authority is implementing those basics for DWPZ.

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

No, they are drawn according to the hydro-geological circumstances.

DWPZ (zone 1+2) are delineated parcel-specific within the relevant spatial plans, whereas large DWPZ ("Trinkwasserschongebiete") do not have to be delineated mandatory within spatial planning instruments – depending on the respective planning authority.

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

Borders of DWPZ are drawn without regarding ownership relationships due to the relevant hydrological investigations. The respective water supplier has to negotiate with the affected land owner.

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

The DWPZ are delineated parcel-specific within the "Wasserbuch", which is available at the district administration ("Bezirksverwaltungsbehörde") for all land owners. In some municipalities this "Wasserbuch" is already available online. Furthermore the borders of DWPZ are also shown up in the respective land use plan ("Flächenwidmungsplan").

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

The water supplier is obliged to control the relevant DWPZ. Furthermore the Water Authority makes unannounced inspections once a year. Every five years a civil engineer for land and water management makes an on-the-spot check ("technical external monitoring") – commissioned and paid by the relevant water supplier.

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

If breaches of the requirements of a DWPZ are recognized (e.g. in terms of the Austrian Federal Water Act), this has to be reported to the authorities. The extent of punishment is determined within the Austrian Federal Water Act.

Water suppliers and land owners are party in case of any legal conflicts. The position of land owners is stronger than the position of water suppliers. Due to this fact the city of Vienna has bought a huge part of the related DWPZ and hence actually is there land owner.

2.3. Specific Example of Research within the Viennese DWPZ: Alpine Karst Region with scarce vegetation (Example how water suppliers exercise control over their DWPZ)

2.3.1. Interpretation of process based maps

This chapter describes the state-of-the-art concept of process based maps (generation, interpretation and application) regarding the interplay of direct infiltration and surface runoff in karstic catchments. Examples are taken from recently conducted studies in the catchments of the Vienna Water Works.

2.3.1.1. Generation

Field mapping is performed combining classical hydrogeological methods with hydrological process identification based on the existing hydrogeological map and a pre-defined mapping catalogue. In a first step, lookout points are located to overview the area and identify possible homogeneous areas and surface runoff traces from afar. In a second step, representative points on these areas are selected to prove assumptions and to map few parameters regarding debris/soils. According to hydrogeological methods the emphasis are field investigations based on hydrogeological mapping and field measurements in order to gain extensive knowledge about processes and their spatial distribution in the catchment. Based on the hydrogeological map, which describes the lithological units relating to their hydrogeological quality rating, mapping focuses on infiltration capability of the overlaying loose material/debris and potential surface flow lengths towards sinks and karst forms (Figure 2). The idea is to map a large number of points and polygons with less detail rather than few points with a lot of detail. Strictly applying hydro-geological mapping principles implies that only those items are included which are possible to categorize in the field. These principles are extended by the “process-oriented” view. The method enables to map a large area in a high alpine, remote region, without using a regionalization model.

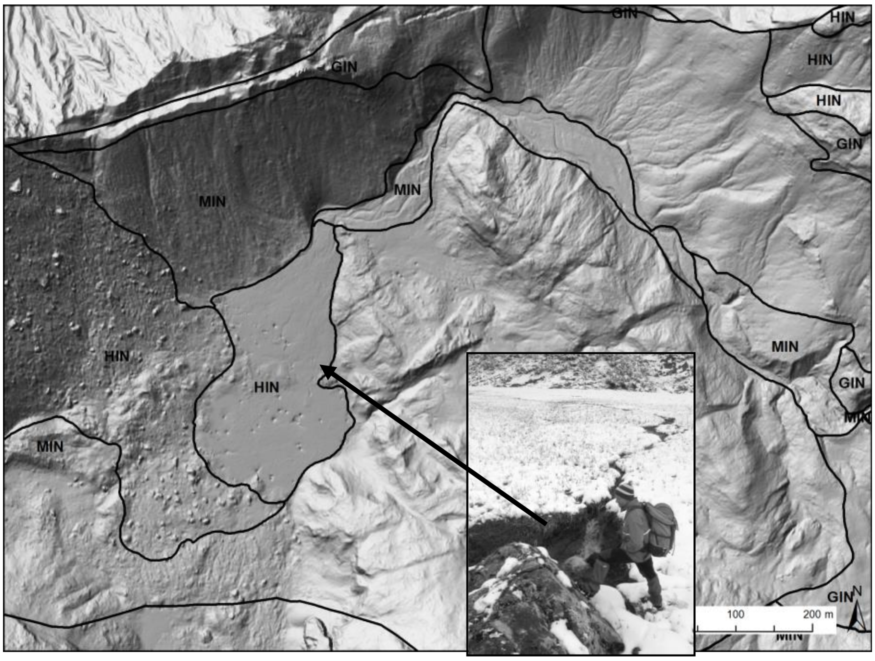


Figure 2 Example of mapped polygons in an area with characteristic morphology (highlighted by 1m Laser-scan): Infiltration classes: HIN = high, MIN = medium and GIN = low. The photo shows the main sink in this area, where a whole creek infiltrates into the karst system.

2.3.1.2. Interpretation

Proposed main mapping items are

- Lithology type
- Loose material, debris, soils
- Vegetation development

It is clear that, in addition several other items can be used (e.g., soil depths), but emphasis here lies on the possibility to categorize in the field, as well as on the idea, that types and properties indicate the main (dominant) hydrological processes on an area. These can be transferred to other similar areas, and provide functional supplements of the underlying hydrogeological map.

Types of lithology are typically limestone, dolomite, etc., which are mapped based on the existing geological map but also confirmed in the field. In a hydrogeological context they differ mainly in their degree of karstification and thus, the direct infiltration vs. surface runoff potential.

The item “loose material/soils” is mapped by classifying the type of the material, related to its origin (weathering), and in-situ determination of fine grain size fraction (sieving with 2mm mesh). It is assumed that a higher fraction of fine material increases storage capacity and decreases permeability. Furthermore mapping of visible traces of temporary surface runoff and a permanent drainage network is incorporated. **Table 1** shows examples of classes, and expected dominant processes are assigned to the properties. For example, the dominant process in high permeable coarse debris is direct infiltration and surface runoff does not occur. Underlying karstified limestone results often in subsequent deep percolation and a drainage network is not evident. In steep slopes surface runoff is very likely, which is confirmed by surface runoff traces (e.g., gullies). At areas with fine organic soils the soils are mostly linked to less karstified/permeable geology and flat morphology. Surface runoff occurs once the small storage is filled. In these areas relatively high soil moisture is measured (TDR), partly water logging and pronounced drainage networks are found.

Table 1 Examples of types of overlaying loose material/soils in an alpine karstic catchment and estimated dominant processes.

Overlaying loose material/soil type	Dominant processes
Bare rock (karstified)	Direct infiltration and subsequent deep percolation
Bare rock (not karstified)	Immediate surface runoff (so-called “Horton Overland Flow”, Horton, 1933)
High permeable debris at the bottom of steep slopes	Direct infiltration, but at high rainfall intensities surface runoff (gullies)
Rockfall material	Direct infiltration
Soils with high fraction of fine material	Surface runoff when soil storage is exhausted
Soil with significant organic components (humus), above impermeable layer	Low storage, surface runoff and subsurface flow, drainage network (so-called “Saturation Overland Flow”, Dunne, 1983)

Vegetation development is mapped in two classes, dense and scattered vegetation, and further stratified into pastures and forest, if necessary. Also wetness indicators are mapped that indicate water storage capacity, possible water logging and subsurface flow paths (method according to Markart et al., 2004).

As a synthesis of the mapping general Infiltration capacity of the loose sediments and soils is estimated and stratified into three classes. The properties are related to a typical aestival storm (return period of app. 1 year). **Figure 3** shows an example of the distribution in an alpine catchment in Austria. Grey polygons denote the different Hydrological Response Units (HRUs) which are delineated by the combination of the different mapping items. The map shows a rough overview about areas where surface runoff is likely at typical conditions and is overlaid with automatically generated sinks from a 3m DEM for further interpreting and verifying the map.

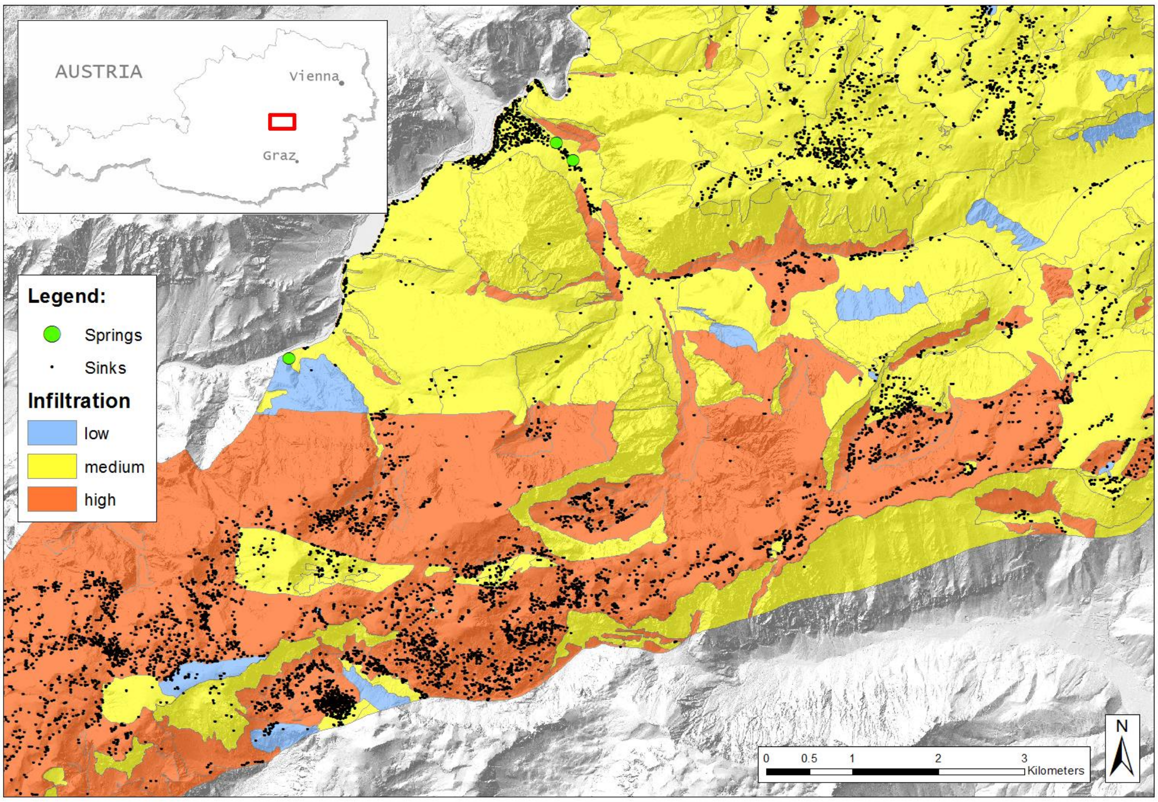


Figure 3 Mapped infiltration capacity in karstic areas (Hochschwab and Zeller Staritzen) overlaid with automatically generated sinks from a 3m DEM. Grey polygons denote the different HRU borders.

2.3.1.3. Application in karst water management

In a vulnerability context quality management of karst springs comprises quantifying potential hazard of surface erosion and thus, the hazard of solute input into the karst system, particularly during aestival thundershowers. During these events, the generation and flow paths of surface runoff play an important role for material mobilization and transport. A process based map can be used in this risk assessment. The advantage over usually applied hydrogeological maps is that, in addition to the basic properties, infiltration capacity and runoff components and, in particular surface runoff propensity can be mapped. However, a map is static information, typically related to a certain event type, i.e. rainfall intensity or hydrological situation (e.g., soil moisture status). Surface runoff generation is different depending on the hydrological situation and in different “phases” of an event.

In order to analyse dynamic patterns of processes and runoff components, a transient hydrological model is necessary. These maps – and the corresponding process description as meta-information – are the basis for the transposition of the mapped properties into hydrological processes and, hence into hydrological model parameters in a certain area (Hydrological Response Unit - HRU). Dominant processes derived from mapping lead to dominant parameters (Dominant Processes Concept – DPC, Grayson & Blöschl, 2002). The idea is that parameters are dominant for representing a certain process at a particular hydrological situation (e.g., Reszler et al., 2008). This implies a deep discussion about process description and nomenclature between mapper and modeller. For parsimony, process description can start with so-called “End-Members” of the possible process spectrum.

Figure 4 shows examples of characteristic landscape in an alpine (karstic) catchment. The left photo shows areas with a dense river network and only scattered sinks where, after exceeding the small storage capacity of the organic soils, a very high fraction of surface runoff is expected. The right photo shows areas with calcareous debris where complete punctual infiltration with subsequent deep percolation into the karstified underground occurs. A priori model parameter values are assigned in a way that the characteristic behaviour on each model element is represented. Usually, applying a spatially distributed model, the model elements are pixels (grid), and several pixels - not necessarily neighbouring pixels - are pooled to one HRU.

In the example of the left picture, soil storage parameters will be set to relatively low values and surface flow parameters become dominant. In contrary, in the case of the debris in the right picture, the parameters representing percolation into the karst system are dominant; model parameters must be set in a way that surface runoff is not simulated, e.g., by setting a threshold for surface runoff, which is implemented in many rainfall-runoff models, to a very high value. Other HRU types lie within these "end-members", and model parameters can be found in relation to these.

The a priori parameters serve as a starting point of model calibration. The possibility of fixing parameters in the calibration procedure reduces the degrees of freedom and the high number calibration runs to accurately represent the runoff reaction at the catchment outlet. However, often in karstic catchments calibration is limited, because catchment boundaries are not known. Therefore, model validation must focus on a plausibility check of simulation results (indirect validation, Reszler et al., 2008) of the different HRUs, relying on the process definition described above.

With the distributed model dynamic surface runoff patterns at different events and hypothetical rainfall scenarios can be produced. Based on these results land-management strategies can be developed.

Figure 4 Example of areas representing characteristic processes at both ends of the spectrum ("End-Members"). Left: areas with a very high fraction of surface runoff (organic soils, very dense river network, only scattered sinks); right: areas with complete punctual infiltration (no river network, very high number of sinks).

2.4. Floods/droughts management

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

  Federal Water Engineering Administration ("Bundeswasserbauverwaltung") develops hazard zone plans and risk assessments as well as the provision of information for municipalities and affected people along rivers. The construction of protective measures takes place on the basis of planning processes, from river basin planning to general and detailed project planning.

  According to the Austrian Forest Act the Forest Engineering Service on Torrent and Avalanche Control (WLV) is responsible for the relevant hazard zone maps and the respective protective measures within the catchments of torrents.

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

  The EU Flood Risk Directive was implemented within the Austrian Federal Water Act. Therefore the catchment-based water management comprises the assessment and the management of flood risks every six years. First of all a temporary assessment of flood risk was conducted within all river basins leading to the provision of potential significant risk areas. For these areas flood hazard and flood risk maps were developed. Based on these results the Flood Risk Management Plan 2015 was published containing targets and measures for risk reduction.

  Also torrent related risks are shown in relevant hazard zone maps based on intensive surveys within catchment areas and evaluation of previous events. The extent of risks is shown parcel-specific through the distinction between "red" (high risk – absolute construction ban concerning new buildings) and "yellow" (medium risk – official requirements for new buildings) zones based on long-term experiences of relevant experts.

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

  Yes, see above (for settlements and important economic assets and transport assets need protection against floods occurring statistically every 100 years - HQ 100 ; assets of lower significance, e.g. roads, are to be protected against HQ30); areas used for agriculture and forestry are not to be specifically protected.

  Concerning torrents also so-called "red zones" and yellow zones" are shown within the respective hazard zone maps (see above).

- Is there a map of floods/droughts risk?

  Hazard zone maps (responsible institutions: Federal Water Engineering Administration for rivers; Forest Engineering Service on Torrent and Avalanche Control for torrents) – see above

- Is there an estimation of what and/or how much damage will occur if flood risk area will be flooded?

Yes, experts try to estimate possible damages due to their experiences and by means of computer-assisted models.

2.5. Water quality state, trends and monitoring

- Who performs monitoring of drinking water quality, which parameters are routinely observed and how frequent?
  Who performs monitoring of drinking water resources (surface water, groundwater…) quality, which parameters are routinely observed and how frequent?
  Is there systematic monitoring of quality parameter trends for drinking water and for their resources? Who performs this monitoring?

Systematic **monitoring** of surface and groundwater (GW) quality and quantity is mandatory due to the WFD and the Austrian "water status monitoring regulation" ("Gewässerzustandsüberwachungsverordnung"). 179 parameters have to be surveyed. The most important subgroup within pesticides is the "pesticide-group 1"comprising Triazine with parameters like Atrazin and Desethylatrazin. This group has to be observed regularly.
The amount of parameters to be observed depends on the quality status of the respective GW body and the regional circumstances. GW bodies at risk or GW bodies which are not of good status are monitored up to 4 times a year ("operational monitoring"). In case of "surveillance monitoring" (GW bodies in good status) at least 2 measurements per year are to be carried out at the monitoring points.
The groundwater monitoring system also covers protected areas. In Austria drinking water protected areas are only relevant for groundwater abstraction points for drinking water supply, and are monitored according to the Drinking Water Directive. In addition to the national monitoring system, the drinking water suppliers conduct self-monitoring in protected areas.

In Austria drinking water is being derived mainly from groundwater (porous GW, karst/fissured GW - springs, deep GW).

Table 2: Amount of groundwater monitoring points for the observation of water quality of porous, karst/fissured and deep groundwater bodies due to the relevant river basin

Einzugsgebiete	Messstellen zur Überwachung von		
	Porengrundwasser	Karst- und Kluft-grundwasser (Quel-len)	Tiefengrundwasser
Donau	1.570	337	26
Rhein	60	12	0
Elbe	14	0	0
Österreich gesamt	1.644	349	26
	2.019		

Source: NGP 2015

In case of these three types of groundwater – relevant for drinking water in Austria – no risk of failure of "good status" could be observed. Therefore no operational monitoring is necessary.

Emissions into surface water are registered in the "emission register" due to the Emission Register Directive (EMREG-OW, 2009) – see Table 2. But as surface water is not relevant for drinking water purpose in Austria, these problems are not really relevant.

The drinking water suppliers in some cases conduct water quality measurements on their own. The city of Vienna carries out continuous on-line measurements of turbidity values and SAC (Spectral Absorption Coefficient) at each spring. If the values of the source water exceed the defined threshold values, the water of the respective spring is discharged to the stream instead of being transported via the water main to Vienna. The water quality security has been improved through this on-line monitoring program.

Also in Waidhofen/Ybbs SAC data are online available for the karstic springs. Other water quality parameters are measured quarterly.

- Who is the user of this data?

BMLFUW and all water related authorities on regional and local level. In case of specific monitoring cases of single water suppliers, they are the users of their own data or of the gathered data.

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

Measure bundles are decided (see National Water Management Plan). In case of negative quality trends, water suppliers (A) Intend to identify the reason for the negative trend, (B) Search for the spatial dimension of the Driver and (C) Intend to eliminate the cause for the negative quality trend.

In some cases water protection tours are carried out yearly in order to check the status of potential contaminants for the source waters. People who are working or living within the DWPZ are informed in the course of those tours about the relevance of water protection measures.

3. Actual land use activities

3.1. Land use map

Task 1: In this chapter, a land use map shall be outlined on national level. The map should be based on Corine land cover 2012.

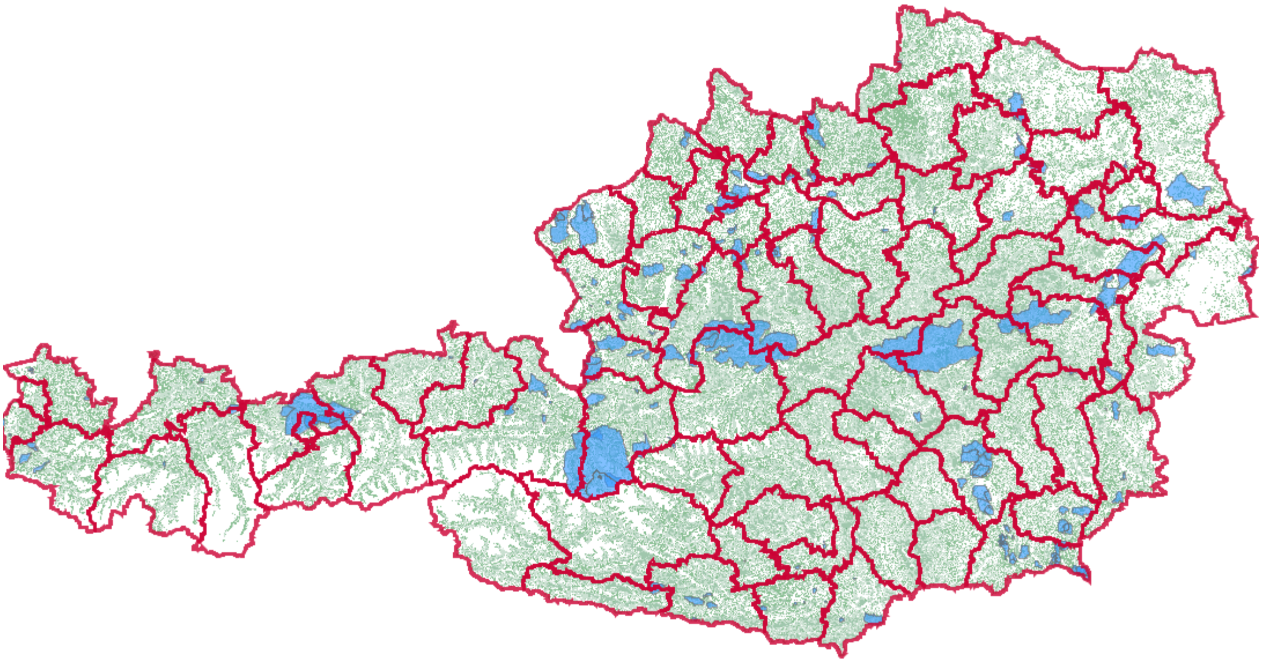


Figure 5: Drinking water protection zones (DWPZ) in Austria. The background-layer displays the forest cover. About 7 % of the Austrian territory are DWPZ.

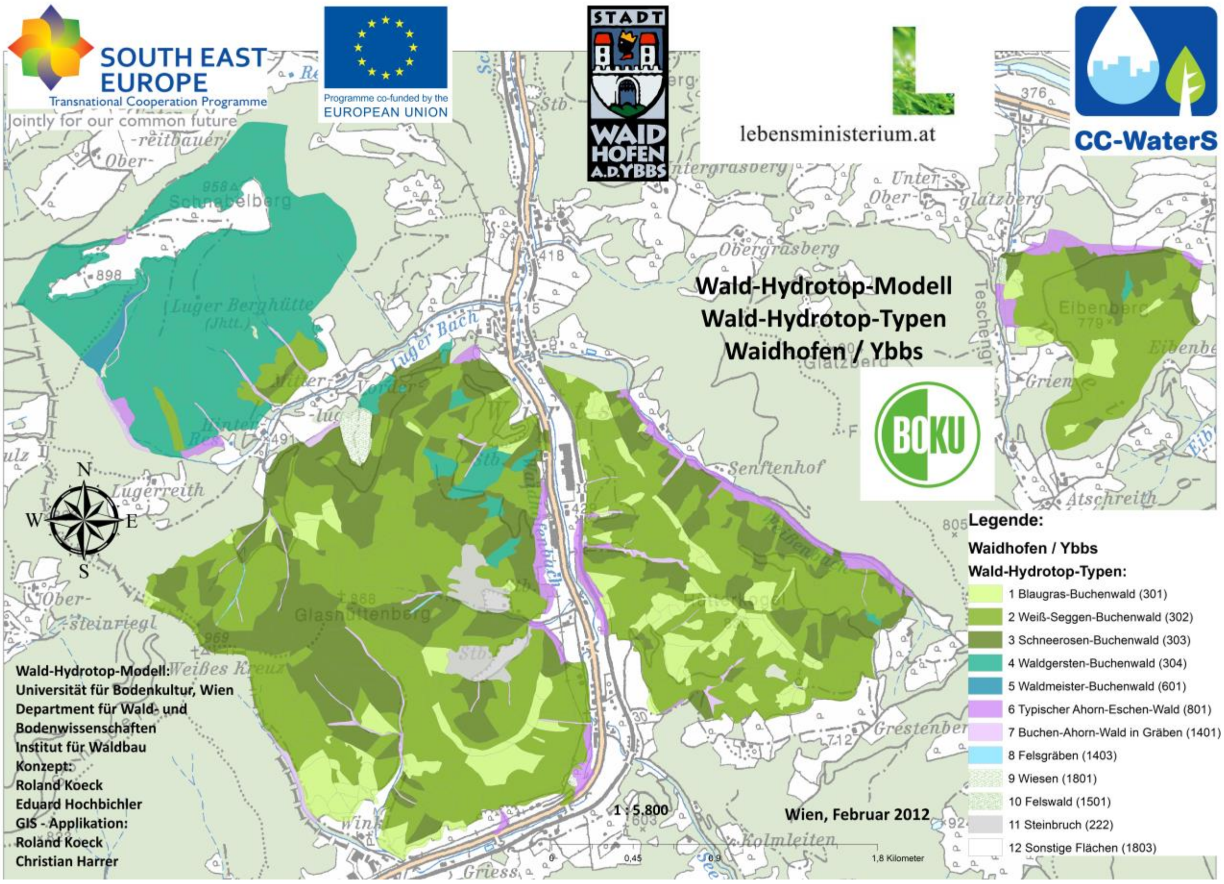


Figure 6: Forest Hydrotope Map of the DWPZ Waidhofen/Ybbs(www.ccwaters.eu)

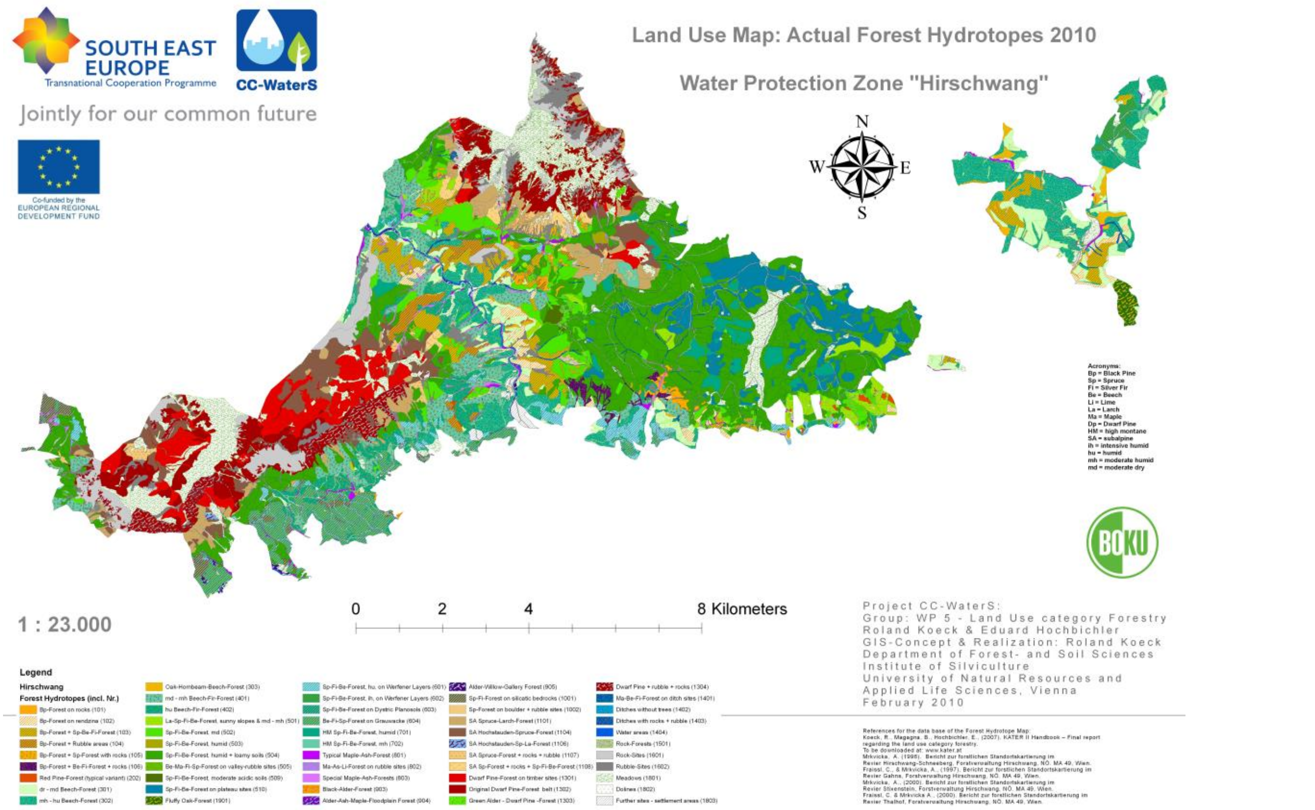


Figure 7: Forest Hydrotope Map of the Viennese DWPZ 1 (www.ccwaters.eu)

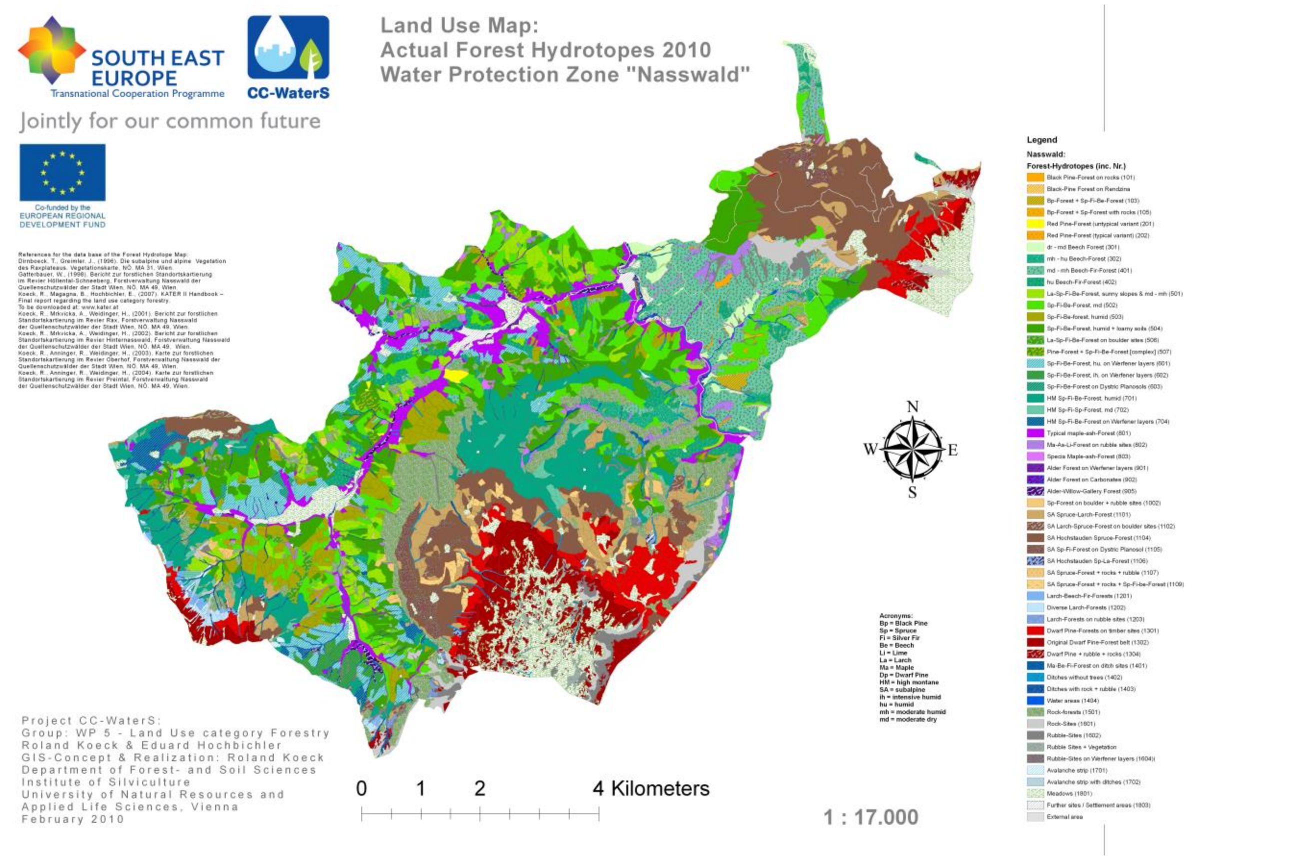


Figure 8: Forest Hydrotope Map of the Viennese DWPZ 2 (www.ccwaters.eu)

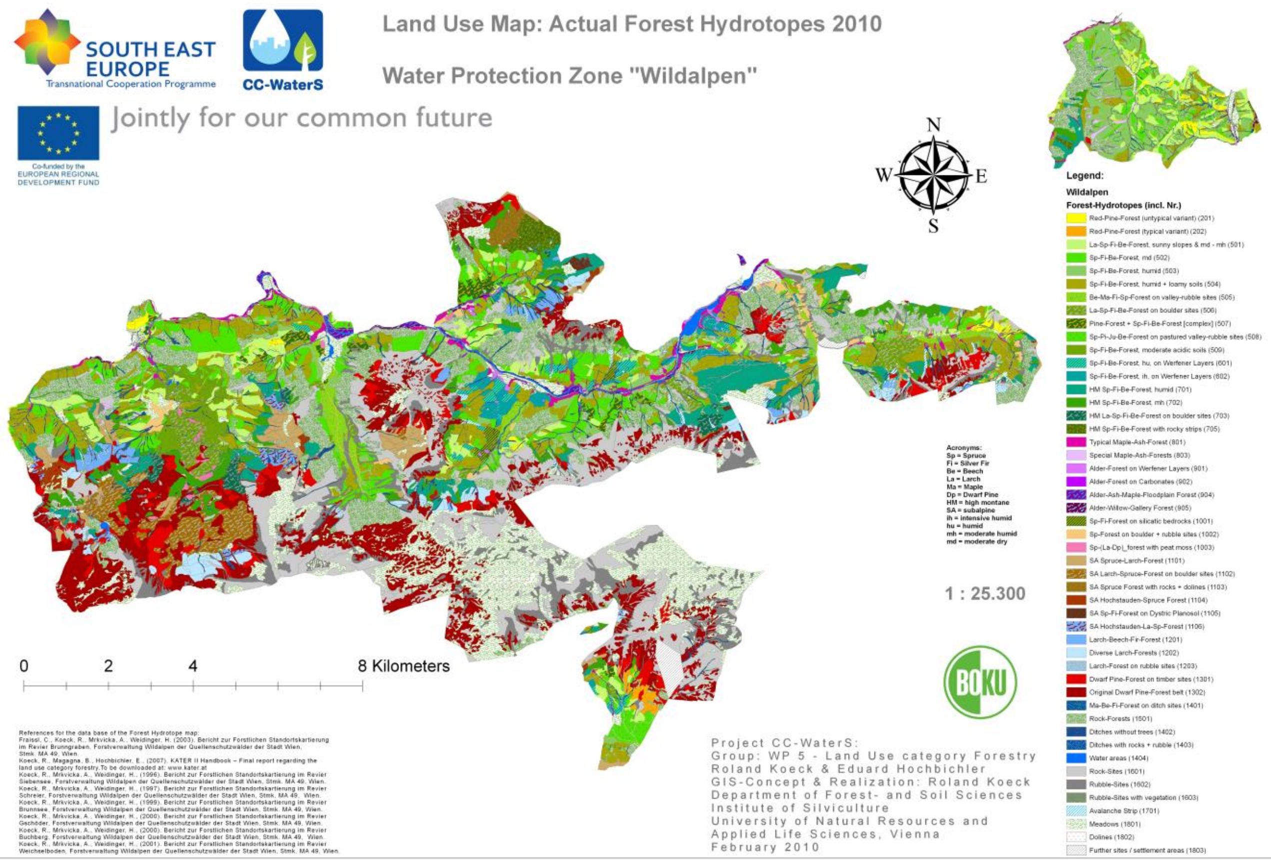


Figure 9: Forest Hydrotope Map of the Viennese DWPZ 3 (www.ccwaters.eu)

Using **Corine Land Cover 2012 (LABEL 3)** in GIS, the land cover types within the most important water protection zones (WPZ) in Austria were analyzed. The data of the WPZ as shape file was provided by BMLFUW (2016). The whole area of the WPZ sums up to 5742.21 km^2, what is 6.8 % of the Austrian territory. According to the CLC2012 data, the most prevalent land cover type within the WPZ is coniferous forest with a share of 21.8 % (Tab. 1). The share of all three forest types sums up to 39.39 % of the total WPZ area. Non-irrigated arable land covers 19.1 % of the WPZ. Also of importance are bare rock areas which cover 7 % of the Austrian WPZ (Tab. 1).

It has to be mentioned that for management purposes within WPZ the Corine data are not enough, all Austrian project partners possess the Forest Hydrotope Model for their WPZ, which provides a detailed stratification with relevance for management decision processes (Fig.2, 3, 4 & 5). As overview about the land cover in Austria’s WPZ, the Corine land cover map is the adequate solution (Fig. 6).

All displayed WPZ represent the most important ones of Austria, hence there is no claim for completeness of the WPZ data.

Table 3: Land Cover types according CLC 2012 in Austria‘s most important water protection zones (WPZ)

CLC Code	Land Cover Type (CLC 2012)	Percentage (%)	Area (km²)
111	Continuous urban fabric	0.2	13.62
112	Discontinuous urban fabric	5.7	329.40
121	Industrial or commercial units	0.8	47.82
122	Road and rail networks and associated land	0.1	8.39
124	Airports	0.08	4.80
131	Mineral extraction sites	0.2	11.18
132	Dump sites	0.00	0.37
133	Construction sites	0.02	0.91
141	Green urban areas	0.2	10.22
142	Sport and leisure facilities	0.4	25.82
211	Non-irrigated arable land	19.1	1096.75
221	Vineyards	0.6	33.05
231	Pastures	3.7	210.51
242	Complex cultivation patterns	2.4	135.05
243	Land principally occupied by agriculture, with significant areas of natural vegetation	2.6	148.36
311	Broad-leaved forest	5.0	288.88
312	Coniferous forest	21.8	1253.59
313	Mixed forest	12.5	719.88
321	Natural grasslands	3.4	193.89
322	Moors and heathland	7.9	453.49
324	Transitional woodland-shrub	0.3	19.95
332	Bare rocks	7.0	404.29
333	Sparsely vegetated areas	5.3	303.74
335	Glaciers and perpetual snow	0.1	6.71
411	Inland marshes	0.00	2.71
511	Water courses	0.1	7.14
512	Water bodies	0.2	11.77

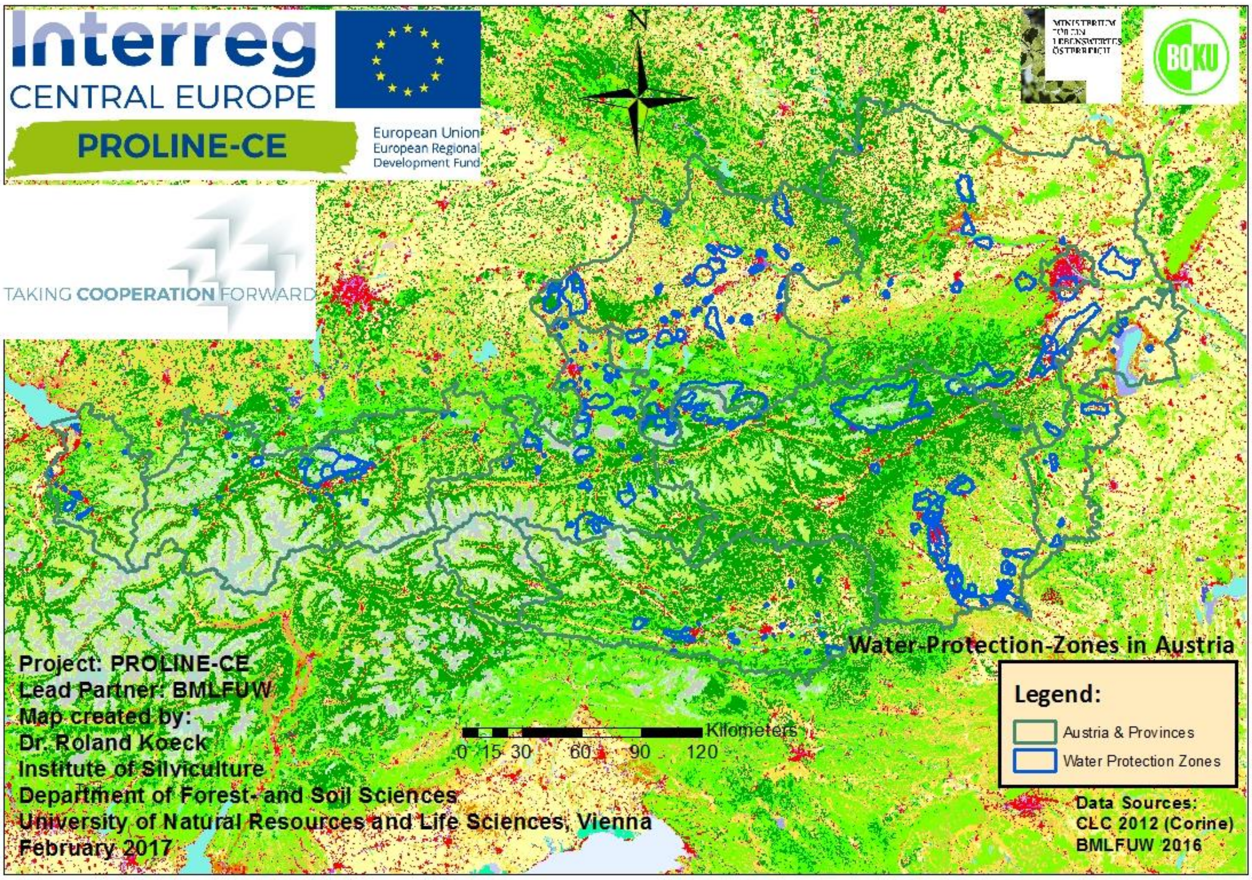


Figure 10: Water Protection Zones in Austria, displayed with Corine land cover data (CLC 2012)

3.2. Overview of the particular land use activities

3.2.1. Urban areas

Task: To what extent is built sewer system at the state level (percentage rate). What type of waste water 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?

The **sewage** disposal and treatment are carried out by means of 1,842 local purification plants and are mainly provided by municipalities or outsourced enterprises and associations. The connection rate to the sewer system in Austria is 94.9 % (2011). Only three sewage treatment plants (> 2000 inhabitants) discharge their waste water into groundwater on the basis of water permissions, but they do not cause any degradation of groundwater quality status. Due to national requirements all municipal sewage plants have to be equipped with carbon-extraction. Moreover, most of the plants have a further wastewater treatment stage (phosphor-/nitrogen-extraction). The cleaning power achieves 80 % of N and 90 % of P. Nevertheless, measures that will further reduce ammonium, zinc, AOX and copper emissions are foreseen in the future.

Concerning **waste management** Austria takes a leading role in Europe. The recycling rates (66 % - 96 %) are higher than the EU requirements. Innovative technologies and solutions, e.g. in the field of emissions reduction during waste incineration or waste use in industries, enable Austrian manufacturing companies to use know-how transfer to foreign countries.

Unfortunately due to 126 **contaminated sites** ("Altlasten") punctual pollutions of groundwater are expected or already existing (NGP 2015). These sites are systematically registered and analysed since 1990.

To avoid or reduce damages through **floods** various measures in terms of an integrated flood management (prevention, response, aftercare) are pursued:

- Legal requirements in spatial planning (no buildings within areas of HQ_{30} – "red zone"; special construction conditions within areas of HQ_{100} – "yellow zone"; "residual risk areas" indicate possible flooding in case of failure of protection structures or exceeding HQ_{100} – hatched in red and yellow) – hazard zone maps (for individual parcels of land). Hazard zone maps of the Federal Water Engineering Administration (Bundeswasserbauverwaltung) serve as a basis for emergency plans, general planning, project planning and expert´s reports. They are available to all municipalities, provincial and federal authorities and the general public via web (www.hora.gv.at).
- Preventive flood protection: natural retention of water in riparian forests and meadow lands
- Structural flood protection (up to HQ_{100}): embankments, dams and flood storage reservoirs
- Provisions: precautions, creation of awareness, prognosis models and emergency plans

Since 2013 flood events are documented in a "flood scientific data base" ("Hochwasserfach-Datenbank") to build up a nationwide standardized and enhanced data base. In the flood risk management plan ("Hochwasserriskikomanagementplan") targets for risk reduction are defined and adequate measures and their priority for target achievement are determined.

Concerning **torrents** there are separate hazard zone maps (since about 30 years) as another authority is responsible (WLV – Forest Engineering Service in Torrent and Avalanche Control of BMLFUW) according to the Austrian Federal Forest Act, delineating red and yellow zones as well as in some cases also risk zones due to gravitational hazards. The same rules apply as for rivers (see above).

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 waste water from industrial facilities treated?

Due to the contribution to GDP (2015, Statistik Austria) following **industrial branches** are important for Austria:

Metal production and –processing, engineering, production of data processing and electrical equipment, food and beverage production, production of furniture and other goods, chemical and pharmaceutical products, paper production.

Regarding water consumption and waste water emission especially following industrial branches are relevant: paper production, chemical industry, production of glass and metal.

Table 4: Direct and indirect discharge of companies due to the EMREG-OW, water amount and selected pollutants, 2012

				Werte Ablauffrachten [kg/a]			
Nace 2-Steller		Anzahl Betriebe	Wasser-menge [m^3/a]	CSB	Phos-por gesamt (als P)	Stickstoff gesamter gebundener (als N)	TOC
10	H.v. Nahrungs- und Futter-mitteln	29	8.078.733	3.293.859	27.084	85.598	975.109
11	Getränkeherstellung	3	362.494	594.311	13.363	21.498	198.084
16	H.v. Holzwaren: Korbwaren	2	204.301	122.508	14	12.996	39.482
17	H.v. Papier/Pappe und Wa-ren daraus	18	111.420.342	33.899.885	67.086	294.760	11.354.823
20	H.v. chemischen Erzeugnis-sen	18	55.809.032	4.264.904	46.869	1.023.330	1.367.380
23	H.v. Glas/-waren Keramik u.Ä.	5	3.483.009	2.496	3.681	28.038	69.070
24	Metallerzeugung und – bearbeitung	24	85.173.918	1.409.264	4.584	231.260	360.115
25	H.v. Metallerzeugnissen	20	1.096.878	81.398	42.688	23.581	22.807
	Sonstige Sektoren	90	158.630.613	4.664.977	20.012	284.300	1.181.594
	Insgesamt	**209**	**424.259.319**	**48.333.603**	**225.381**	**2.005.361**	**15.568.463**

Source: NGP 2015

Taking into account the trends observed concerning water abstraction and the expected production increase, the industrial water demand will probably decrease between 5 % and 15 % till 2015. Therefore also the waste water amount is expected to decrease till 2015 (NGP 2015).

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 do you manage floods/droughts in agricultural areas?

More than 30 % of the Austrian territory is used for agriculture. In the year 2010 more than 173,000 agricultural and forest operators (farmers) cultivated a total area of 7.34 Mio. ha with an average farm size of about 19.3 ha (2014). Within the river basin areas most of the area (42 % of the Danube river basin, 72 % of the Rhine basin) is cultivated through feed crop farms ("Futterbaubetriebe"), whereas cash crop farms ("Marktfruchtbetriebe") (e.g. grain, sugar beet growing) and also permanent crops ("Dauerkulturbetriebe") (wine, intensive fruit growing) are mainly widespread within the eastern Danube area. Grain growing is the dominant agriculture within almost all river basins in Austria. Maize is mainly cultivated within Mur, Rhine and Drava river basin, whereas potato growing decreased due to the increase of maize in the last decades. Only within Elbe and March river basin potatoes are a little bit more cultivated. The amount of organic farming in Austria is the highest within the EU – 20 % of agricultural areas (14.5 % of cropland, 26 % of grassland). Due to favourable climatic and hydrological conditions only about 2.3 % of the agricultural areas have to be irrigated [11. Umweltkontrollbericht, 2016].

In principle the results of the nitrogen balance show the highest surpluses within the regions with a high livestock density (some areas in Styria and Upper Austria as well as some valleys in Tyrol and Salzburg). But these nitrate surpluses were mostly identified (except the Traun-Enns-Platte in Upper Austria) below the Austrian average amount of 39.7 kg/ha. Pollution of groundwater through **nitrate loads** occurs indeed mainly in the eastern part of Austria, where on the one side intensive agricultural use takes place and on the other side yearly precipitation is relatively low. These circumstances cause negative effects on groundwater recharge and dilution.

Figure 11: groundwater bodies and monitoring points (at risk: red points) – “monitoring-“ (yellow) and estimated “measure-areas” (red) and trends concerning nitrate

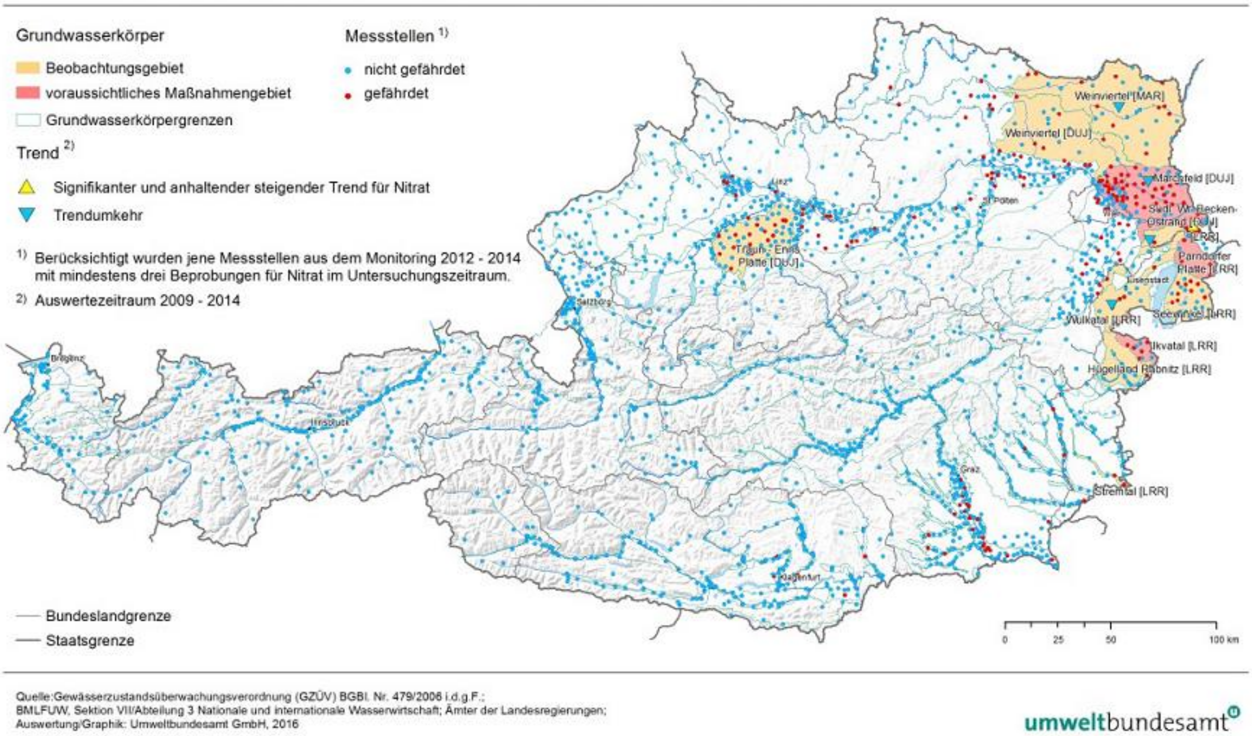


Table 5: Groundwater bodies at risk – "monitoring-" and estimated "measure-areas" 2010-2012 inclusive trend results due to Quality Objective Ordinance (QZV) – Chemical Status of Groundwater

GWK	GWK-Name	Fläche (km²)	Nitrat	Ammoni-um	Ortho phosphat	Atrazin	Desethyl-atrazin	Desethyl-Desisopro-pylatrazin
GK100020	Marchfeld [DUJ]	942	vM (47/72; T)					
GK100021	Parndorfer Platte [LRR]	254	vM (5/7; T)					
GK100035	Weinviertel [DUJ]	1.347	B (6/16)					
GK100039	Mittleres Ennstal (Trautenfels bis Gesäuse) [DUJ]	80		vM (5/9)	B (3/9)			
GK100057	Traun - Enns - Platte [DUJ]	810	B (15/50)					
GK100081	Wulkatal [LRR]	386	vM (4/9; T)					
GK100094	Böhmische Masse [MAR]	1.367			vM (4/10; T)			
GK100095	Weinviertel [MAR]	2.008	vM (14/32; T)					
GK100123	Weststeirisches Hügelland [MUR]	907						vM (2/4)
GK100128	Ikvatal [LRR]	165	B (4/9)					
GK100129	Lafnitztal [LRR]	96			B (7/17)			
GK100134	Seewinkel [LRR]	443	B (11/24)					
GK100135	Stooberbachtal [LRR]	12			B (1/3)		B (1/3)	
GK100136	Stremtal [LRR]	50	B (2/5)		vM (3/5; T)	B (2/5)	B (2/5)	
GK100146	Hügelland Rabnitz [LRR]	498	B (1/3)					
GK100176	Südl. Wiener Becken-Ostrand [DUJ]	209	vM (9/13)					
GK100178	Südl. Wiener Becken-Ostrand [LRR]	276	B (2/6)					
GK100183	Hügelland zwischen Mur und Raab [MUR]	862		B (6/15)	B (5/15)			
Summe (km²)			7.388	942	2.467	50	62	907
Summe (B/vM)			(7/5)	(1/1)	(4/2)	(1/0)	(2/0)	(0/1)

B	*Beobachtungsgebiet*
vM	*voraussichtliches Maßnahmengebiet*
T	*Wenn ein signifikanter und anhaltender steigender Trend festgestellt wird, ist ein Grundwasserkörper ebenfalls als voraussichtliches Maßnahmengebiet gemäß QZV Chemie zu bezeichnen.*
(x/y)	*An x von y untersuchten Messstellen wird der parameterspezifische Schwellenwert gemäß QZV Chemie GW überschritten.*

With regard to **phosphor loads** it can be assumed that only low amounts of phosphor from surface water are leached out into groundwater bodies. Therefore no risk due to phosphor is estimated. In Austria pressures through phosphor are mostly observed in surface water bodies (rivers and lakes) due to erosion processes from surrounding agricultural areas [NGP 2015].

Concerning **pesticides** (investigation period 2011 – 2013) following substances or metabolites (based on 131 in total) show the most frequent excesses (related to the monitoring points): Desethyl-Desisopropylatrazin, N,N-Dimethylsulfamid, Desethylatrazin, Bentazon, Atrazin und Terbuthylazin. Excesses occur mainly within the intensive agricultural areas in Upper Austria, Lower Austria, Styria, Burgenland and surroundings of Vienna. [11. Umweltkontrollbericht]

In case of medium soil- and weather conditions and proper application within seepage water near groundwater annual average concentrations above threshold (0.1 µg/l) are predicted only for the prohibited (since 1995) Atrazin (0.2 µg/l) due to the material transfer model GeoPEARL-Austria (BAW Petzenkirchen und Netherlands Environmental Assessment Agency). In case of unfavourable circumstances the predicted annual average concentrations for Atrazin and Triclopyr are 2 µg/l. Especially humus-poor, well permeable and medium/shallow soils are at risk and have to be observed particularly. Furthermore an application in autumn leads to more discharges than in spring [NGP 2015].Concerning management of **floods** agricultural areas will become more important as potential retention areas due to presumed increasing floods in connection with climate change. In this context the scope of water-legislative obligations for planning permissions was extended due to the amendment of the Austrian Water Law. This could promote the enforcement of the availability of further retention- and flooding areas. [11. Umweltkontrollbericht, UBA 2016]

3.2.4. Forest

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

The total forest cover of Austria encompasses 3,990,000 ha, what are 47.6 % of the total area. About 71.6 % are conifer and 28.4 % are deciduous tree species. The Austrian forest ecosystems are dominated by Norway spruce (*Picea abies* – 59.7 %), what is due to the high share of mountain forest sites and, above all, due to the establishment of spruce plantations on sites of various other forest communities. The most prominent deciduous tree species is European beech (*Fagus sylvatica* – 10.2 %). Further important conifers are European larch (*Larix decidua*), Scotts Pine (*Pinus sylvestris*) and Silver fir (*Abies alba*). Prominent deciduous species are oak (*Quercus robur, Quercus petraea, Quercus cerris*, etc.), ash (*Fraxinus excelsior*) and maple (*Acer pseudoplatanus, Acer platanoides*, etc.).

Actually forest ecosystems are used for the protection of drinking water sources (e.g. in case of the cities Vienna, Waidhofen/Ybbs, Salzburg, Innsbruck, Graz, etc.). Also the use for the protection from floods is important. There are various flood protection forests situated all over the country. Due to the mountainous character of parts of Austria, there exist very special declared protection forests, providing shelter from floods, torrents, rock-fall, land slides and avalanches. These protection forests of Austria (category without timber production - 12.5 % of the total forest area) have to provide this ecosystem service and are legally decreed (Forest Development Plan – Map).

In case of the city of Vienna, the use of the forests for the protection of the karstic water sources is a clearly defined purpose, special internal guidelines regulate the silvicultural measures applied in the drinking water protection zone (DWPZ). In Waidhofen/Ybbs the regulation of silviculture within the DWPZ is part of the ongoing project, guidelines are already defined, but knowledge transfer to the stakeholders and Best Practices application still have to be fulfilled. The other cities of Austria, which use forest ecosystems for water protection purposes have individual regulations. There does not exist a binding national guidance for forestry within DWPZ.

The most important issue of silviculture in DWPZ is the transformation of homogeneous conifer plantations into mixed forest stands, intending a tree species diversity conforming with the natural forest community. This provides more stability and resiliency for the forest ecosystems, hence ecosystem services can be delivered in a sustainable way. But this can only be achieved, if Best Practices for forested DWPZ are additionally applied. The whole package encompassing the application of 'Best Practices', information about natural forest communities (Forest Hydrotope Model) and the knowledge transfer to stakeholders is in PROLINE-CE the major task in the field of forestry, as there still exist shortcomings in Austria in general.

The shortcomings are related to the wide spread application of the clear-cut technique, to the also wide spread homogenous Norway spruce plantations on various forest sites and to the browsing damages caused by wild ungulates.

Within more than 2/3 of the Austrian districts more than 50 % of the forest area is damaged by browsing of wild ungulates. Within 25 % of the Austrian districts those damages occur on more than 75 % of the forest area. The tendency of browsing damages is increasing (period 2010/2012) in comparison to the period 2007/2009 [11. Umweltkontrollbericht, UBA 2016]. The stability and resiliency of the forest ecosystems is endangered through browsing damages, as natural regeneration and tree species diversity are threatened. This can be regarded as major threat for the provision of the ecosystem service 'water protection', both in relation to the protection of drinking water resources and to the mitigation or prevention of floods.

Protection from droughts can be regarded as less relevant within the Austrian territory, as the precipitation regime mostly covers the water demand of the forest ecosystems. Within the context of climate change drought events could become more frequent. The stability and resiliency of forest ecosystems in those cases depends on the tree species composition of the forest stands, which has to be adapted in DWPZ according to the potential natural vegetation. Diverse forest ecosystems show more stability, also under drought conditions.

The most important target of forestry within DWPZ in Austria can be summarized with the improvement of forest ecosystem stability and resiliency for providing sustainable ecosystem services within the context of water (water protection, water provision and water regulation). This can be achieved through the implementation of tree species diversity according to the natural forest community (e.g. application of the Forest Hydrotope Model) and through the application of Best Practices in forested DWPZ.

3.2.5. Pastures

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

Livestock farming is a prominent land-use type in Austria, what is due to the dominance of alpine landscapes. The related grassland is either used as hayfields or as pastures, in some cases hayfields are partially used as pastures. Another type of grassland is forage cropping (e.g. red clover, etc.). In the accessible flatlands and alpine valleys of Austria grassland covers 1,600,000 ha and is mainly used for feeding livestock. More than 60 % of the Austrian farmers have a pure grassland focus. At those grasslands mainly farm manure is used, only 5 % of the farmers use mineral fertilizers. Liquid manure is a wide spread form of fertilizing grasslands.

A very important type of pastures are the so-called mountain-pastures, situated in the Alps, where livestock is allowed to graze only during summer season, what is due to climatic conditions (extended snow cover). Those mountain pastures (=Almen) in Austria sum up to 8,770 and cover an area of 460,000 ha.

The challenge of grasslands and mountain pastures in relation to DWPZ is in most of the cases the potential microbial contamination of the source water, caused by farm manure or e.g. cow dung. In some exceptional cases also nitrate leaching to the aquifers could be a threat for source water quality. Within DWPZ it is necessary to regulate the activities of livestock-farming, what especially becomes mandatory in karstic catchment areas.

Within the DWPZ of the City of Vienna, cattle-grazing is regulated in a way, that dolines and sink-holes are fenced so that cattle cannot approach these highly vulnerable sites. Through these measures the critical dung of cattle is intended to be kept in distance to the areas, which have direct connection to the aquifer. In order to avoid the direct entrance of precipitation water also technical constructions were used, like e.g. dams which prevent precipitation water from directly flowing into dolines or sinkholes. The water can subsequently infiltrate slowly via the soil matrix, so that the potential contaminants are reduced (soils are acting like a filter).

Also the erosion processes caused by trampling damages through livestock (above all cattle) can become a threat for source water quality. For avoiding such erosion processes, fencing of erosive sites was done for keeping livestock away from there. A subsequent planting with autochthonous vegetation is a further step towards prevention of such erosion processes.

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 transport units that could have negative impact on water quality?

A mandatory part in the course of planning, construction and maintenance of motorways in Austria is the environmentally compatible removal of wastewaters. The drainage and purification of surface waters stemming from the motorway is constantly brought up-to-date in cooperation with the experts of the water authorities. For this purpose so-called retention-basins were and are constructed beside the motorways.

The water-retention-systems prevent an eventual contamination of the groundwater bodies. All waters flowing from the motorway during precipitation or thawing events enter these retention systems and are cleaned there. First after this cleansing process the waters are transported for infiltration into the ground or enter streams (brooks or rivers).

The purification plants also serve for the prevention of accidents. This means that in case of a leakage of environmentally hazardous materials, those matters can be stored in the retention basins and subsequently can be brought to a professional disposal. This contributes to safeguarding the quality of the streams and groundwater resources (ASFINAG 2016).

Freezing on motorways is prevented by the application of thawing salts, in most of the cases NaCl. During some extreme events also $CaCl_2$ is mixed with NaCl, what provides more security for the drivers, as the mixture can thaw ice and snow also under conditions of lower temperatures, but it also causes more rust-damages on the cars. In Austria about 200,000 tons of thawing salts are applied during one winter season, sometimes even more (depending on the weather conditions). The influence of thawing salts on water resources is given, it can be critical if roads or motorways are crossing DWPZ. An alternative would be the application of KCl_2 in DWPZ, which is not that harmful to plants or to water quality, but has a strong alkalizing effect.

Transport units which drive huge construction materials are accompanied by a special task force, which provides the security of the units. The distance to the trucks is secured, also the signals for other motorway users are provided. Transport units which drive hazardous materials (chemicals, radioactive material, etc.) have to fulfil the laws regulating these transportations.

3.2.7. Stone quarries, mining activities

Further land use categories which impact water resources and flood protection are mines and stone-quarries. Those mining activities occur in various cases in Austria, also within DWPZ.

One specific case of stone quarries is situated within the DWPZ of Waidhofen/Ybbs. Those stone quarries, where dolomite was mined, are currently abandoned, but the status of the extraction areas has to be adapted according to the Austrian law. This situation causes the extension of the extraction areas, as the angle of the remaining rock-face is not allowed to be steeper than 45°. Due to this law the already abandoned mines have to be shaped, stones are again mined, and the area of the stone quarries has to be extended for achieving the defined angle of the rock-faces. This causes an extension of the area where water infiltration into the aquifer does not occur in such quantity and quality like e.g. in the case of undisturbed soil layers. Rock areas facilitate surface runoff, what is not desired within DWPZ. After the adaptation of the rock-face angle the mine area is intended to be afforested with trees and soil vegetation.

The potential impacts of active stone quarries on the aquifers are resulting from the applied detonations, from the trucks which can cause oil-spills and from further applied chemicals. Hence it can be concluded that mines and stone quarries should not be situated within DWPZ.

A different condition is given in the case of gravel pits situated in groundwater aquifers along rivers, which are also very important as potential supra-regional drinking water resources in Austria. Those gravel pits are in many cases opening the groundwater horizons, the groundwater becomes surface water and could be contaminated through various impacts due to the lacking gravel and soil cover [NGP 2015]. In general it should be avoided to construct or run gravel pits within DWPZ.

3.2.8. Tourism: Ski Stations, Alpine Huts

Tourism can exert various impacts on aquifers, water courses or lakes. Here only some relevant activities are discussed.

Ski stations have potential negative impacts on aquifers. Those are resulting from sewage waters from restaurants or huts without sewage systems, from potential oil-spills caused by snow-groomers or emissions stemming from the transport facilities (cable-ways, chair-lifts, drag-lifts, etc.). In most cases the potential contamination is restricted to mineral oil products utilized for those facilities. The potential contamination stemming from groomers and transport facilities can be minimized, if the technical maintenance of those devices takes place periodically and also in acut cases in a very strict way. Further chemicals which are applied in the ski station should be restricted to the minimum and in necessary cases applied with outmost care.

The process of artificial snow-making can involve various potential impacts on aquifers and streams. Within DWPZ it should be forbidden to add any chemicals or additives to the source-water for artificial snow-making. The source water for the snow-making process should be withdrawn taking environmental care into consideration (water balance of the region, only clean water can be used, micobiologically contaminated waters are not allowed to be used without prior treatment, etc.). The storage reservoirs have to be constructed taking the environment into consideration. Especially the respective Nature Conservation Acts and the Water Acts have to be considered. The process of ski-station-extensions (with cable-ways or also with artificial snow-making-facilities) provoces discussions in Austria, where various governmental and non-governmental institutions are involved. Environmental Impact Assessments are obligatory and the public has a very critical position towards ski station extensions. Despite this fact actually many ski stations extend their areas of operation on various levels (cable-ways, artificial snow-making, new ski-slopes, etc.).

There is only one small ski station situated within the DWPZ of the city of Vienna. The restrictions for this specific ski station are strict, the restaurants are connected with a sewage channel and the technical facilities used have to be maintained in very good condition. There is no artificial snow-making taking place there.

Alpine shelter huts occur e.g. within the DWPZ of the city of Vienna, which is situated within the Northeastern Limestone Alps of Austria, a renowned hiking area. Several alpine associations run the shelter huts in this area, hikers stay over night or just visit for eating and drinking. The main problem with those huts is the sewage water, which could potentially enter the aquifers within the karstic alpine landscape. Due to this potential threat all shelter huts within the DWPZ of the city of Vienna have been equipped with a sewage system. Some of them have now a sewage channel, directly connected with sewage treatment plants in the valley. Others have a sewage channel to a temporary storage, which can be disposed by special trucks. Huts which are situated very remote, have been equipped with special compost-toilets, which are disposed by helicopters. This initiative was part of the integral water protection policy of the city of Vienna. The sewage facilities were partly financed through the municipality of Vienna.

It is also important to inform the tourists about their responsabilities regarding source water protection. Information should be available at spots where many tourists are passing. This was already implemented in many DWPZ in Austria, improvement potential is of course given.

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

KTM = Key Types of Measures; DW + FL = Driving Forces with impacts on drinking water protection and flood prevention

Impact on water resources quality				
URBAN AREAS				
Driving forces	Pressures (on water)	State (ESS)	Impacts (on environment)	Responses (MEASURES)
Contaminated sites ("Altlasten")	Punctual pollution of groundwater	Punctual high values of pollutant in groundwater	Punctual deterioration of groundwater quality	KTM 4: Implementation of appropriate measures; Remediation of contaminated sites
Floods (along rivers & torrents)	Temporary increased turbidity values caused by heavy rainfall events	Floods are increasing and water quality can be influenced negatively	Destruction of buildings and infrastructures; Erosion processes	KTM 6 + 7 + 23: Integrative flood risk management (monitoring of the risk management plan); Acceleration of natural water retention measures; KTM 12 + 13 + 15: Best Practice implementation (avoidance of discharge – and erosion-increasing measures, adaptation of land-use in areas close to rivers/torrents, , conservation and improvement of protection forests); Strategy for flood events caused by heavy rainfall; Provision and protection of

				flooding and retention areas; Limitation and prohibition of building area zoning; Mandatory consideration of hazard maps within spatial planning (area zoning); Preference for non-structural measures; Improvement of ecological functions of water bodies; river basin or catchment-oriented planning of measures
AGRICULTURE				
Driving forces	Pressures	State	Impacts	Responses
Use of fertilisers (especially nitrate consumption)	Diffuse nitrate loads (runoff and percolation) – especially in the eastern part of Austria	Values of nitrates exceed the thresholds in some areas (strengthened by less precipitation) Due to high nitrate concentrations in soils emissions of nitrous oxide ("Lachgas") is increasing	Deterioration of groundwater quality; Negative effects through nitrous oxide emissions on climate protection	KTM 2: Evaluation and amendment of the Nitrate Action Plan every 4 years; Acceleration and evaluation of the effectiveness of the Austrian Agro-Environmental Programme (ÖPUL); Optimization of the application of fertilisers (according to time and amount due to soil samples); Waiver of fertilisers, especially within sensitive areas. KTM 12: Strengthening of consultancy and research programmes; Acceleration of

				organic farming (5. Organic Action Programme, 2015); Effectiveness of Common Agricultural Policy should be improved towards sustainability: Shift of the water intake area to forested catchments (if possible)
Use of pesticides	Diffuse load of pesticides within intensive agricultural areas	Values of some pesticides (especially Triazine) exceed the thresholds within intensively used areas	Deterioration of groundwater quality	KTM 3: Reduction of areas at risk; Continuous monitoring; Restricted licensing; Minimizing and regulation of the application (e.g. application in spring preferred to autumn); Prohibition of pesticide application in DWPZ; Organic farming in DWPZ KTM 12: Funding and consultancy and awareness raising;
Floods within agriculturally used retention areas	Diffuse loads of especially phosphor and nitrate into surface waters	Eutrophication of surface waters	Water quality problems with surface waters	KTM 13: Erosion protection; buffer zones KTM 12: Acceleration of the Austrian Agro-Environmental Programme (ÖPUL)
FOREST				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**

Clear Cut application (DW + FL)	Humus decomposition, soil erosion, increased surface flow, further erosion processes	Decreasing water protection functionality of the involved forest sites (Low level of Ecosystem Services [ES])	Increased turbidity in the source water, increased matter concentration in the source water, Microbial contamination of the source waters, source waters are not able to be used for water supply	KTM 13 + 17: Avoidance of clear-cut applications, application of continuous cover forest systems
Forest ecologically unbalanced (high) wild ungulate densities (DW + FL)	Browsing damages on deciduous tree species and silver fir; fraying damages in case of various tree species; bark stripping damages in case of various tree species	Destabilisation of the forest ecosystems through lacking natural regeneration; Extinction of tree species; Decreasing water protection functionality of the involved forest ecosystems (Low level of ES)	Forest decline, growth of weed species instead of trees at forest sites, erosion processes, rock-fall, avalanches, increased flood damages, contamination of the source water through elevated turbidity, SAC, nitrate, DOC, etc.	KTM 13 + 17 + 22: Balancing the wild ungulate densities to a forest ecologically sustainable level; increased hunting activities with the purpose of forest ecology; resettlement of wild predators like wolves, lynx, etc.
Extended application of the tractor skidder method in the course of timber yield (DW + FL)	Soil compaction on at least 20% of the forest sites; long lasting soil compaction	Water protection functionality in terms of infiltration capacity and water storage capacity disappeared at minimum 20 % of the forest site; Low level of ES	Surface Flow in the course of heavy rainfall events; erosion processes like gully formation, soil erosion; contamination of the source water with various substances (clay, nitrate, DOC, increased turbidity, etc.); increased danger of flood creation through increased surface flow	KTM 13 + 17 + 22: Avoidance of the tractor-skidder method; application of alternatives

PASTURES				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
Livestock grazing close to dolines, swallow holes and streams	Entrance of faeces and faecal micro-organisms to the aquifer	Source waters contaminated with faecal micro-organisms	Source water cannot be used for drinking water supply; or source water creates serious health damages among people; or high costs for the treatment of the raw water	KTM 2: Prevent livestock from grazing close to dolines, swallow holes or streams; Construction of dams etc. what prevents precipitation water from direct and fast entrance into dolines and swallow holes
Intensive application of liquid manure to the grassland	Leaching of the liquid manure (nitrate and faecal micro-organisms) to the aquifer	Source waters contaminated with faecal micro-organisms, nitrate, etc.	Source water cannot be used for drinking water supply; or source water creates serious health damages among people; or high costs for the treatment of the raw water	KTM 2: Limitation of the application of liquid manure: prohibition or reduction in quantity and limitation to days when plants can provide a high nitrate uptake rate.
STONE QUARRIES / GRAVEL PITS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
Active stone quarries / gravel pits situated within DWPZ (DW + FL)	Potential contamination of the aquifer through chemicals and mineral oil products; Increased surface runoff; Loss of soil as filter; Loss of infiltration function of soils	Total loss of Ecosystem Services (ES) within the area of stone quarries / gravel pits	Source waters, which cannot be used for drinking water supply; Increased surface runoff in the DWPZ causing increased flood intensities and erosion in case of heavy rainfall events.	KTM 13 + 17: Abandonment respectively avoidance of active stone quarries /gravel pits within DWPZ; rock-faces have to be kept in original slope for preventing the extension of the stone quarry area through the abandonment process
TOURISM				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
Alpine shelter huts without	Sewage waters entering the	Contamination of the source	Source waters have to be	KTM 1 + 21: Equipping alpine

sewage systems	aquifer	water with bacteria, chemicals and other matter stemming from the sewage waters; ES water provision is destroyed	discharged to the streams or simply cannot be used for drinking water supply; Or: High treatment costs for the contaminated waters	shelter huts with sewage systems; adequate technical solution adapted to the site-specific situation of each hut.
Ski station with artificial snow-making (ASM) in DWPZ	High water consumption for ASM; construction of reservoir-lakes in areas which are sensitive in terms of conservation; snow-groomers with poor maintenance status cause mineral oil spills; restaurants and huts without sewage systems	Potentially: water shortage in parts of the DWPZ; problems with nature conservation targets of EU; entrance of mineral oil into the aquifer; entrance of sewage water into the aquifer	Water shortage and contaminated source water cause problems with drinking water supply; Conflicts with nature conservation on both governmental and non-governmental level	KTM 1 + 13 + 21: Adaptation of ASM to the general water availability of the region; No construction of reservoir lakes in areas which are sensitive in terms of nature conservation; strict maintenance guidelines for snow groomers and other technical devices; Sewage systems for restaurants and huts; Abandonment of ski stations or parts of ski stations situated within an important DWPZ, if possible

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, 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 been developed, has the measure begun? Is it necessary to do anything?

WEAKNESSES

- Due to the "Federal State" structure of Austria regulations in general are different between the "Provinces" (limitations and guidelines for DWPZ, related consideration within spatial planning documents, etc.)
- No specific binding legislative rules for DWPZ in the Austrian Federal Forest Law (e.g. clear cuts are allowed to a certain extent)
- Values of nitrate and some pesticides are increased in the source water due to intensive agriculture (especially in the eastern part of Austria)
- Erosion is still happening widely in Austria, although soil protection acts exist – through soil erosion on agricultural land mainly phosphorus pollution in rivers increases
- Punctual pollution of groundwater due to contaminated sites
- Weak adjustment of adequate land use along rivers / torrents (buildings within hazard zones, over-aged trees, clear-cutting of the gallery-forests along streams, agricultural farming up to embankments…)
- Wide-spread browsing damages caused by wild ungulates: This process hinders natural forest regeneration, brings some tree species close to extinction and endangers all Ecosystem Services provided by forests
- Clear-cut technique as common forest operation occurs wide spread and causes problems, especially in DWPZ
- Livestock-grazing close to vulnerable

STRENGTHS

- Good quality and enough quantity of groundwater
- Austria takes a leading role in Europe concerning waste management
- The amount of organic farming in Austria is the highest within the EU
- Due to favourable climatic and hydrological conditions irrigation of agricultural areas is only necessary in some dry years and areas
- High share of forested DWPZ
- High share of potential future drinking water sources within forested watersheds
- The Alps provide higher precipitation rates, snow storage as water storage far until spring and mountain forest ecosystems with a potentially high level of water protection functionality
- Adaptability of farmers in terms of water protection goals
- Adaptability of governmental bodies to close ski-stations within important DWPZ (e.g. Villacher Alpe in Carinthia)

sites like dolines or streams - Ski-stations with artificial snow-making and inadequate technical facilities within DWPZ - Direct negative impacts (chemical and mineral oil contamination, increased surface run-off and loss of soil) through mining activities or gravel pits situated within DWPZ	
OPPORTUNITIES - To guarantee a sustainable water supply also in the future, adequate water management plans are crucial - Water efficiency programmes and proper water management , especially in dry areas, are necessary in the future - Vulnerability and risk assessment mapping according to state-of-the-art methods should be intensified in karstic areas - Additional quality parameters and other substances should be added to the threshold list and considered for amendments of laws - Improvement of the monitoring system due to densification of the testing network - Stricter laws in general including actual programmes and measures should be developed according to the demands of sustainable water quality and quantity - River basin or catchment-oriented planning of measures - Use of EU funds (Rural Development 2014+) for the compensation of additional expenses due to adjusted forest management measures for drinking water protection - Better communication and dissemination of knowledge and	**THREATS** - the impact of climate change and its effect on (ground)water resources is quite unknown - in the future (due to climate change) groundwater recharge will probably decrease in some areas - causes of adverse change in quantitative and qualitative characteristics of groundwater are not fully identified or understood, especially in karst aquifers - Effects of some substances (pesticides etc.) found in water bodies on human health are unknown and potentially dangerous - Loss of Forest Ecosystem Services due to browsing damages caused by wild ungulates - Increased compaction of forest soils due to the application of the tractor-skidder method during timber yield can cause reduced infiltration rates and increased surface runoff, leading to more severe floods and less groundwater recharge - Potential contamination of aquifers with relation to ski stations with mineral oil products or bacteria stemming from sewage waters from restaurants or huts - Potential contamination of aquifers

experience between decision-makers / legislators and experts - Integrative flood risk management - Further promotion of ÖPUL and organic farming (especially within DWPZ) - Stricter rules concerning fertilizer and pesticide applications and respective awareness raising - Strategic and Integral Source Water Protection Concepts and Planning for DWPZ - Adaptive forest management for drinking water protection in DWPZ - Closing ski stations within important DWPZ - Stricter regulations for ski stations close to DWPZ (sewage systems, strict maintenance guidelines for technical facilities, etc.) - Regulations for alpine pastures or grasslands to fence vulnerable sites like dolines or streams - Regional programmes (designation of suitable areas for material extraction) are planned in Upper Austria and a guideline “protection of groundwater within gravel pits” was developed by the ÖWAV (Austrian Water and Wastewater Association)	due to the entrance of bacteria caused by livestock-excrements - Due to mining activities or gravel pits within DWPZ source waters cannot be used for drinking water supply and increased surface runoff causes floods and erosion Within gravel bodies along rivers (especially in the Alpine foothills) exist severe conflicts through controversial interests: raw material extraction versus drinking water protection

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