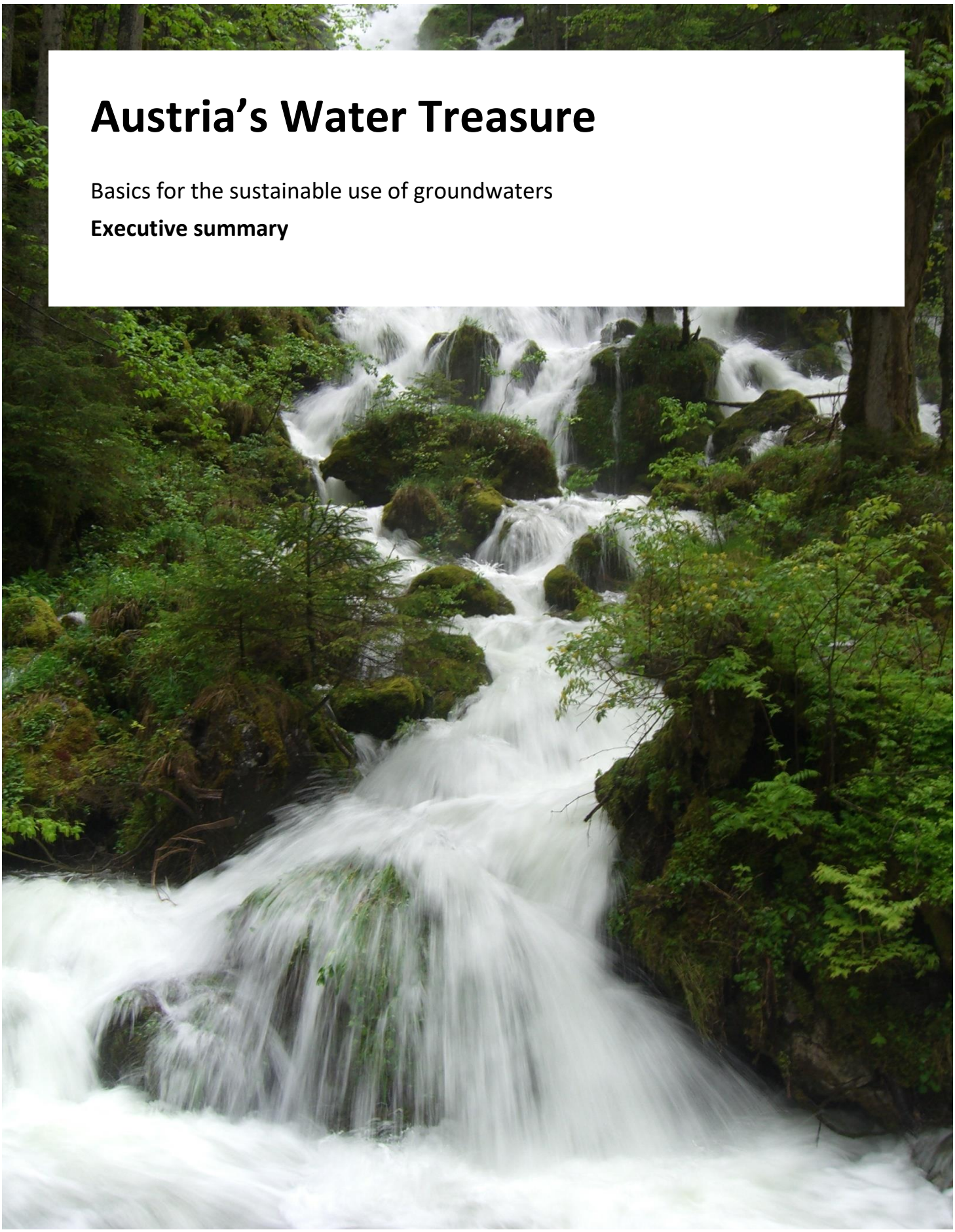
Federal Ministry
Republic of Austria
Agriculture, Regions
and Tourism

Austria's Water Treasure

Basics for the sustainable use of groundwaters

Executive summary



Impressum

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Summary

Austria is marked by a high volume of water resources. They develop via springs and waterfalls into mountain torrents and rivers, feed lakes, mark the landscape and are invisibly stored in the underground as groundwater. These resources constitute an important basis for drinking water supply, agriculture, industry, trade and tourism. In order to ensure that "Austria's Water Treasure" can be protected on the long run and used in a sustainable way, a foresighted orientation of water management planning is required. The Federal Ministry of Agriculture, Regions and Tourism has thus commissioned the study "Austria's Water Treasure", to develop on the basis of the current water utilisations and available resources scenarios for the time horizon 2050 from the perspective of climate change.

Sustainable groundwater management pursues first and foremost the goal of ensuring the supply of the population with drinking water at the highest level. Moreover, it is important to ensure agricultural production and thus food supply and food security as well as to maintain and strengthen the business location including tourism. This has to take place under the prerequisite that the ecological functions of the water bodies and terrestrial ecosystems depending on groundwater remain guaranteed – adapted to the respective natural area.

With the project "Austria's Water Treasure" comprehensive foundations for the sustainable management of groundwater resources for the next 30 years are made available for the first time. This means:

- The sustainably utilisable ("available") groundwater resources and
- the demand for drinking water supply, trade and industry, agriculture and for selected services has been identified.
- The water demand has been contrasted to the available groundwater resources and is identified as the "utilisation intensity of the groundwater."

It is presented for the current situation and for the time horizon until 2050, taking into consideration different climate scenarios and assumptions on socio-economic changes. The results are then represented as a range between two especially defined water

treasure scenarios 2050 “favourable” and “unfavourable” with respect to the utilisation intensity of the groundwater.

For the sectors water supply, agriculture, trade and industry, as well as for selected services, numerous different datasets, such as entries into the official register of water permits, have been evaluated and assigned to the groundwater bodies. For a selection of water rights actual water abstraction data have been collected. These data have been supplemented by means of involving representatives of the Federal Provinces and numerous stakeholders adding results of studies and assessments by experts. Based on these data the total water demand has been identified and again assigned to the respective groundwater bodies. With the available data and the supplementary surveys a sound demand model for water supply could be developed. By means of a combined approach, taking into consideration the different data sources, a regional assignment of the water demand could be carried out for the trade and industry sectors. As far as agriculture is concerned, the assessment made is subject to uncertainty due to lacking data. The available groundwater resources have been identified by means of the methodology, which is also applied within the framework of the “National Water Management Plan” (NGP Nationaler Gewässerbewirtschaftungsplan) and refined by means of more small-scaled assessment and by including further meteorological and hydrological datasets. In this way an assessment, which is comparable all over Austria, and unique as far as its level of detail is concerned, is available for the whole Austrian territory. By means of a comparison between the available groundwater resources and the well extractions the utilisation intensity of the groundwater has been identified. On the basis of the current groundwater, utilisation scenarios for a time horizon until 2050 have been worked out, taking into consideration the effects of climate change as well socio-economic developments. The presentation is made at the level of the water management reference units of groundwater bodies and/or due to the requirements of the spatial resolution of climate scenarios in so-called “scenario regions” derived from it.

With the results of the project “Austria’s Water Treasure” an important contribution to the implementation of national and European climate change adaptation strategies, as well as to reaching the United Nations Sustainable Development Goals SDGs has been made, in particular to SDG 6 (Clean water and sanitation) and SDG 15 (Life on land). Data bases are submitted, taking into consideration climate-related effects and risks, which will subsequently be included in the discussion and the development of recommendations for actions as well as in further plans in the field of water management at regional level.

The results of the present study on the current water utilisations were used for the draft of the third “National Water Management Plan” as an important basis for the assessment of the quantitative status of the groundwater bodies.

Climate change

The effects of climate change become more and more apparent, also in Austria. Dry periods, as in the years 2003, 2015 and 2018, and extreme weather events, such as long-lasting heat periods or severe rainfall are increasing. Changes in the precipitation rate, the rise in air temperature and the related effects on evaporation (evapo-transpiration) and the change of the vegetation period have an immediate impact on the water resources and their availability as well as on the water demand. In general a seasonal shift of precipitation – an increase in precipitation in winter and spring, and a decrease in summer and autumn is expected for Austria. However, these changes can have different degrees, depending on the region. At the same time the evapo-transpiration will rise accordingly with the rise in temperature, so that there might be, in particular in the summer period, an increase in extremely dry periods.

Three regional climate scenarios of the project “ÖKS15 – Klimaszenarien für Österreich” “ÖKS15 – Climate Scenarios for Austria”, which was commissioned by the Federal Government and the Federal Provinces, were used as a basis for this study for the assessment of a realistic range of potential future impacts of climate change on the water resources.

- Intermediate RCP 4.5 scenario – “optimistic assumption” – “great efforts in the field of climate protection and a moderate population and economic growth” with an “average precipitation situation”.
- Intermediate RCP 8.5 scenario – “intermediate assumption” – “little effort in the field of climate protection and unchecked population and economic growth” with an “average precipitation situation”, and
- Extremely dry RCP 8.5 scenario – “pessimistic assumption” – “little effort in the field of climate protection and unchecked population and economic growth” with “declining precipitation”.

The effects of climate change on the groundwater resources and on the water demand were identified on the basis of the datasets “ÖKS15 – Klimaszenarien für Österreich“

(ÖKS 15 Climate Scenarios for Austria) with the signals of change for precipitation, air temperature and evaporation to be expected (data on a monthly basis in a 1x1 km² grid), made available by the Institute for Meteorology of the University of Natural Resources and Life Sciences. It is assumed that the scenario 2050 is the medium value of the climate period 2041-2070.

Water Treasure Scenarios 2050 "favourable" and "unfavourable"

The availability of water resources and the water demand until 2050 depend on several factors. Apart from the development of the climate, for which the above-mentioned climate scenarios were used as a basis, potential socio-economic changes, e.g. population development or changes in agriculture and industry and their effects on the water demand will play an important role. These regionally very different developments were taken into consideration in two water treasure scenarios, especially defined for this study and contrasted with the available groundwater resources in the regions. The result of this comparison is the utilisation intensity of the groundwater. The central question of the studies was how the utilisation intensity will develop until 2050.

The results are available within a range of two potential Water Treasure Scenarios 2050. The "Water Treasure Scenario favourable" is the one with the lowest utilisation intensity, the "Water Treasure Scenario unfavourable" is the one with the highest utilisation intensity. The results are represented in a way covering the whole federal territory of Austria at the level of 89 scenario regions.

Water resources

Due to the effects of climate change the available groundwater resources in Austria can decrease by the time horizon of 2050 by about 23 % from presently 5.1 billion m³ to 3.9 billion m³.

The total annual precipitation of 1,190 mm, which falls on a long-term average on the federal territory, corresponds to a water volume of about 99.8 million m³. Of this volume a major part flows off on the surface and/or near to the surface via the running waters or

evaporates. On Austrian average a share of almost 27 % of the precipitation seeps into the groundwater and is intermediately stored there on a medium- or on a long-term basis.

Up to 5.1 billion m³ per year can be sustainably withdrawn from the groundwater without overexploitation or impairment of ecosystems. This quantity is called “available groundwater resources".

The available groundwater resources are distributed very unevenly in Austria, in particular in those areas with a low precipitation rate they are considerably below the Austrian average. Moreover, the recoverability of groundwater is limited in some areas due to hydrological conditions, and very cumbersome.

For the time horizon 2050 the Water Treasure Scenario “unfavourable” resulted in a decrease of available groundwater resources all over Austria by about 23 %, this means that on a multi-annual average only 3.9 billion m³ groundwater per year are still available. As a consequence of dry periods the availability of groundwater can be, as even today or in the recent past, more restricted in individual years.

Water demand - water supply

The water demand for the Austrian water supply is completely covered by groundwater (wells and springs). The current water demand of 753 million m³ per year will increase by 11 to 15 % by 2050, this means Austria-wide a future water demand of 830 to 850 million m³ per year. In individual municipalities the demand can rise by up to 50 %. The most severe influence on it have population growth and climate change.

The water demand of the water supply is composed of the water utilisation of private households and public institutions, enterprises of trade, industry and agriculture co-supplied by the public supply system, as well as of the self-supply of households. Currently the total water demand amounts to about 753 million m³ per year. This demand of the water supply is withdrawn at about 55 % from wells, which includes also almost 1.5 % deep groundwater abstractions. About 45 % of the demand is covered by springs.

The most important factor of influence on the rising water demand – up to 10 % – Is population growth, in all scenarios. Approximately 2 to almost 6 % of the rise in demand can be assigned to climate change and up to one percent can be caused by rising overnight stay figures of the tourist industry.

Efficiency increases until 2050 will help to reduce the increase in the water demand by about two percent. In total there still remains an increase in demand of about 11 to 15 %. However, at municipal level there could be rises in demand of up to 50 % and demand peaks of up to many times of the respective average.

Water demand – agriculture

The water demand for agriculture, which is covered by self-extractions, comprises the fields of irrigation and watering livestock. The share, which is covered by public water supply, is not included in the following assessment.

Irrigation

All over Austria the share of irrigation in the total water demand, amounting to about 69 million m³ per year, is quite low, however, it is focussed on a few regions in East Austria, and, in terms of time, on the vegetation period. One can proceed on the assumption that the demand will almost have doubled by 2050. Due to a lack of data the figures constitute the best possible expert assessment.

Currently on average 69 million m³ of water are used for irrigation, which are about 2.3 % of the total water demand in Austria. Of which around 64 million m³ are withdrawn from groundwater. About 90 % of the areas, which can be irrigated with the available irrigation infrastructure and water quantity, are located in only nine scenario regions in East Austria. The irrigation quantities vary considerably due to the annual weather conditions and can be up to eight times higher in dry years than in years with an average precipitation rate.

On the basis of studies on agricultural development it is assumed that agricultural areas will decrease all over Austria by eleven percent until 2050. It is also assumed that the total yields from farming will remain at the same level. At the same time one can proceed on

the assumption that in future there will be a reduced water availability from precipitation in the vegetation period, more frequent dry periods, changes of the distribution and intensity of precipitation, as well as extended vegetation periods and required frost protection irrigation. This means that an increased demand for irrigation will be necessary for safeguarding and increasing the yield.

By the time horizon 2050 the water demand for irrigation might increase, depending on strongly varying weather conditions, all over Austria from presently around 69 million m^3 to around 115 to 125 million m^3 per year. The areas for irrigation will extend in future increasingly from the East to the West.

Animal husbandry

The water demand for animal husbandry differs considerably regionally and, amounting to 55 million m^3, makes up a low share in the total water demand. In spite of declining livestock numbers an increase in the water demand is to be expected due to the performance increase in livestock farming and to the increase in hot days.

The water demand for animal husbandry from withdrawals for own use amounts to 55 million m^3 per year. The withdrawals for own use take place half from own wells and half from springs, respectively. The share, which is co-supplied via the water supply system, is not included in it.

By 2050 a decrease of the total number of farm animals by about 22 % is expected, however, as far as the number of cattle is concerned, an increase is to be expected. The water demand per animal was assumed in the scenarios at a higher level due to the performance increase in animal husbandry, such as with dairy cattle. Moreover, the increase in heat days was taken into consideration as well. In the scenarios the assumptions result in a future water demand from 57 to 79 m^3 per year for animal husbandry. As far as the water demand for cattle on Alpine pastures is concerned, which makes up about 1.3 million m^3, there could be – as it had already happened in the past in dry summers – shortages of supply in individual regions.

Water demand - trade and industry

Trade and industry are, with about 2,210 million m³ per year, by far the branch of industry with the highest volume of water abstraction. The abstractions, which are predominantly used for cooling purposes, are made at about 84 % from surface water, which is recycled locally. The withdrawals from wells amount to about 330 million m³ per year. Until 2050 slight changes in demand are expected.

The water abstraction by the producing sector amounts to about 2,210 million m³ per year and thus makes up about 70 % of the total water demand in Austria. About 84 % of which are withdrawn from surface waters, 15 % from wells, and 1 % from springs. The major part of the abstractions from surface waters is used for cooling purposes and, as a rule, recycled locally into the waters.

Of the total of 330 million m³ withdrawn from wells per year around 177 million m³ are withdrawn from wells in the vicinity of big running waters. The abstractions near to the shore include also shares, which are regenerated by immediately inflowing surface waters.

The water demand of the producing sector will remain approximately the same compared to the status quo for the time horizon 2050. Due to structural changes in this sector a reduced water demand is expected on the long run. However, the water demand can change considerably in both directions in individual regions due to the closure, resettlement or extension of individual large enterprises.

Water demand - artificial snow

The water demand for artificial snow amounts to about 48 million m³ per year and is covered at about 90 % from surface waters and only at about 10 % from groundwater. By 2050 a demand of up to 65 million m³ is to be expected.

From the field of services artificial snow and golf were defined as important fields, with the share of irrigation for golf courses being very low. Of the total water demand of 52 million m³ artificial snow makes up the major share with around 48 million m³ per year.

This demand is covered at about 90 % by surface waters. All in all this corresponds to two percent of the total water demand in Austria.

For the time horizon 2050 an increase of the demand to about 65 million m³ per year is expected. This results from a higher specific water utilisation per hectare of area covered by artificial snow, among other things by several times of basic snow-making, if required. Regionally there might also be an increased use of groundwater for snow-making.

Water demand - Total

The total annual water demand in Austria amounts to about 3.1 billion m³, see Table 1. The potential development until 2050 is represented in Table 2.

About 60 % – which are about 1.9 billion m³ – are withdrawn from surface waters, see Figure 1. The major part of it is used as cooling water for trade and industry, a smaller part is used by agriculture and services (artificial snow).

About 40 % of the total water demand – which are about 1.2 billion m³ – are covered by groundwater (68 % wells, 32 % springs). The highest share is used for water supply, a smaller share is assigned to trade and industry as well as to agriculture and services. The focus of the project “Austria’s Water Treasure” is on this water demand, which is covered by groundwater.

Figure 1: Total water demand from ground- and surface water, distribution of the groundwater demand according to wells and springs, as well as according to economic sectors

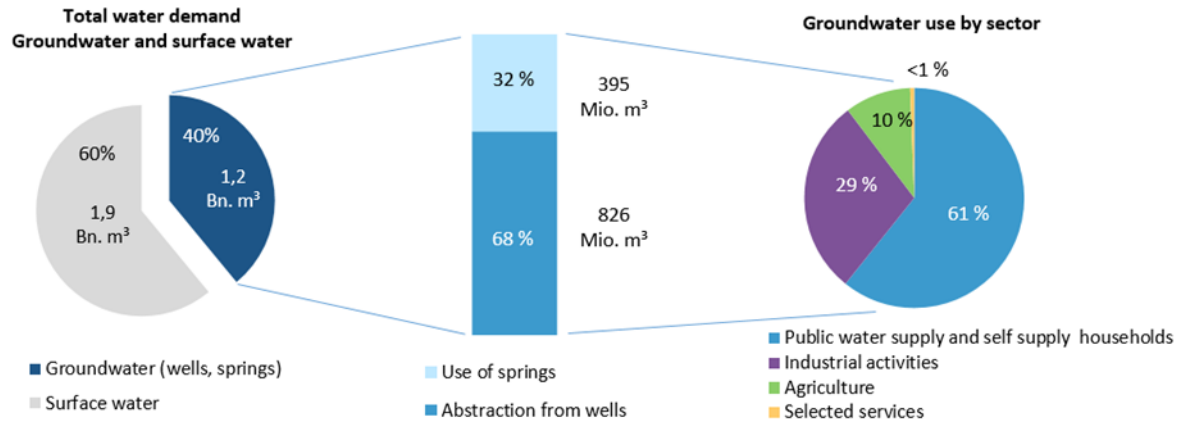
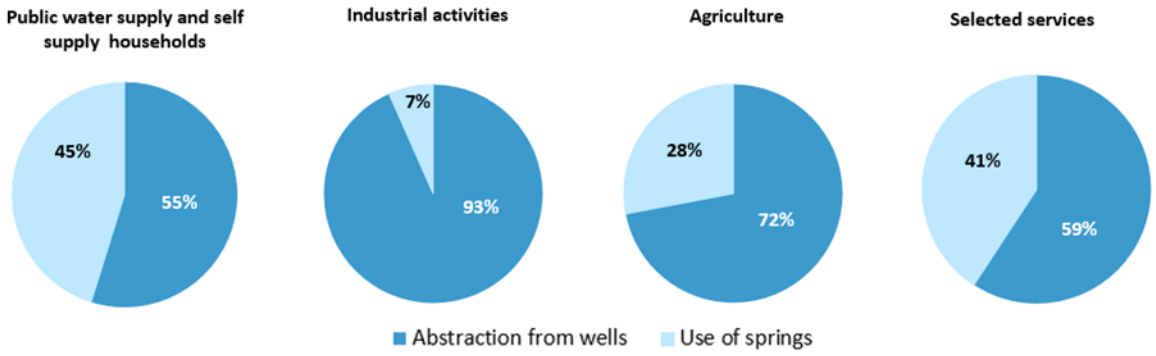


Figure 2: Utilisation of groundwater (wells and springs) according to economic sectors



Utilisation intensity Groundwater

The current water demand can be sustainably covered by groundwater. For the time horizon 2050 the conclusion of the Water Treasure Scenario "favourable" is that the utilisation intensities will rise and the number of areas with a very high exploitation rate (more than 75 to 90 %) will increase, but that the utilisation intensity will remain below 100 % everywhere. The Water Treasure Scenario "unfavourable" indicates that the demand can exceed the available water resources in some scenario regions. Moreover, the utilisation intensity will rise in some other scenario regions. In the course of a foresighted planning process special attention should be paid to scenario regions with an utilisation intensity of more than 75 %. The rising utilisation intensity might result in utilisation conflicts at regional level.

The "utilisation intensity" of groundwater has shown to which share the available groundwater resources can be used. It results from the comparison between available groundwater resources and groundwater abstractions from wells.

The present water demand can be sustainably covered by groundwater at regional level.

On an Austria-wide scale the Water Treasure Scenario 2050 "unfavourable" has shown an increase in the water demand from wells by 21 % from 826 to around 1,000 million m^3 per year and at the same time a decrease of the available groundwater resources by about 23 % from 5,100 million m^3 to 3,900 million m^3 per year. All over Austria the utilisation intensity of the groundwater will increase in the course of the next 30 years from an average of around 16 % to an average of around 26 %.

Regionally the decrease of the available groundwater resources can even amount to more than 30 %, in particular in the water-rich western part of Austria. In the eastern part of Austria the available groundwater resources will decrease more moderately or even slightly increase due to the increase in winter precipitation and the related new formation of groundwater identified in the climate scenarios. However, the rising temperature and the increase in evaporation will bring about an increased water demand in future, which relativizes the rather positive developments of the climate scenarios.

The Water Treasure Scenario 2050 “favourable” identifies a higher utilisation intensity in some scenario regions, however, the demand will be in all regions lower than the respective available groundwater resources. However, according to the Water Treasure Scenario 2050 “unfavourable” the water demand might exceed the available water resources in some regions in the East of Austria.

Dry periods

Apart from the above-described changes, which are to be expected on the long run, the effects of dry periods, as in the recent past, have to be taken into consideration as well. Frequency and extent will increase due to climate change. Particularly affected is the East of Austria.

Table 1: Water demand in million m³ currently

Water demand	Wells	Springs	Deep ground-water	Ground-water Total	Surface waters	Total	Share in the total sum
	million m³	million m³	million m³	million m³	million m³	million m³	%
Water supply	407	335	11	753		753	24%
Agriculture	85	33		118	6	124	4%
Trade and industry**	330	23		353	1,857	2,210	70%
Selected services***	4	3		7	45	52	2%
Total	826*	395*	11	**1,232**	**1,908**	**3,140***	100%

*Total sums contain rounding differences; ↑ rising water demand, → approximately equal water demand.
** The assumptions for 2050 anticipate that the demand for trade and industry will remain approximately the same. ***comprises the water demand for artificial snow and for the irrigation of golf courts.

Table 2: Potential development of the water demand in million m³ until 2050

Water demand - Total	Currently million m³	Scenarios 2050 range million m³	Change of water demand
Water supply	753	830-850	↑
Agriculture	124	182-202	↑
Trade and industry**	2,210	2,237	→
Selected services***	52	63-70	↑
Total	**3,140***	**3,312-3,359**	**↑**

*Total sums contain rounding differences; ↑ rising water demand, → approximately equal water demand.
** The assumptions for 2050 anticipate that the demand for trade and industry will remain approximately the same. ***comprises the water demand for artificial snow and for golf courts.

Recommendations for action

By way of example some general measures will be mentioned subsequently, which contribute on the one hand to preserving the available resources, and have on the other hand a favourable effect on demand, and aim at improving the bases of decisions. Concrete proposals for measures, especially at regional level, are not included and are thus to be worked out subsequently within the framework of a separate decision-making and discussion process with the respective persons responsible and the stakeholders.

Water demand

- By means of efficiency-raising measures and by means of the utilisation of better bases of information, as well as the increased use of digital technologies for water demand control, the efficiency, such as in the field of irrigation, shall be further improved.
- Moreover, options will be reviewed, whether by means of changing or adapting the type of management the water demand can be reduced.

Water resources

- By means of appropriate measures, e.g. unsealing, the water retention capacity of soils, terrestrial and aquatic ecosystems shall be promoted and/or restored. This leads to a water retention in the region and supports also the new formation of groundwater.
- In order to ensure the drinking water supply the further development of supra-regional supply systems and the creation of failsafe infrastructure (2nd pillar) shall be further pursued.

Bases of decision

- As a basis of planning in the field of water management information on demand and water resources development has to be worked out and the situation concerning the available data on current water abstractions has to be improved. On the basis of the current and future developments the authorised water abstraction quantities (consensuses) have to be reviewed, and, if required, adaptations have to be made. This applies in particular to sectors, where fields of tension and competing utilisations become apparent. By means of the documentation of dry periods and their effects, the bases of planning shall be supplemented with respect to challenges, which are mostly small-scaled and limited in time.
- On the basis of the experiences made in the course of previous dry years instructions for the way of dealing with water scarcity shall be worked out. In the course of this process for example priorities have to be set in the field of water utilisations, and drought risk management plans, emergency plans, etc. have to be developed.
- Further studies shall be made on the field of topics cooling water abstractions and water temperatures.

In particular the results of the Water Treasure Scenario 2050 “unfavourable” have shown that the measures in the field of climate protection already taken or planned are of utmost importance. The system is very inert and reacts slowly. It is necessary that the efforts in the field of climate protection are not only taken in Austria, but also on an international scale. In order to ensure the availability of water resources in Austria until 2050 and beyond that, it is necessary to take precaution in regions with potential fields of tension in order to be able to synchronise the claims on the utilisation on the long run and in a sustainable way, taking into consideration the ecological functions of the bodies of water in the respective natural area.

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