The Current State of Groundwater and Drinking Water

A Survey Issued by the *Qualitätsgemeinschaft Bio-Mineralwasser e.V.*

The Black Book of Water Quality – Part IV

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Background information: The primary goal of the Qualitätsgemeinschaft Bio-Mineralwasser e.V. is to ensure that the quality of our water – the fundamental basis for all life – is the best it can be for this generation as well as for those who will follow. The quality seal for Organic Mineral Water is recognized and supported by six of Germany's leading organic associations Bioland, Naturland, Biokreis, Demeter, Bundesverband Naturkost Naturwaren and the Assoziation ökologischer Lebensmittelhersteller (Association of Organic Food Producers). The quality seal has two main purposes: independent monitoring of mineral water quality and the effective protection and preservation of water quality. Organic mineral water companies, which bottle water at the source, are essentially "organic water farmers". They are concerned with the constant renewal and generation of water and protecting the integrity of natural water sources through facilitating organic farming practices.

Methodology: The core of the work performed by the Qualitätsgemeinschaft is to conduct research and to continuously collect information on the condition of and the problems associated with groundwater, potable water and mineral water in Germany and beyond. Central to this endeavor are official data from the federal government and from the individual states showing changes which occur in water quality over time. Both clearly indicate that actions to protect and monitor water quality are urgently needed due to the existing levels of water pollution. Since 2017, the Qualitätsgemeinschaft Bio-Mineralwasser e.V. has been regularly publishing its research as a survey, also referred to as "The Black Book on Water". As time goes on – these publications are providing increasingly comprehensive data regarding the condition of groundwater and tap water in Germany in an easily understandable form. In order to stimulate a fact-based, social and political discussion

on the topic, the Qualitätsgemeinschaft Bio-Mineralwasser e.V. makes its findings available free of charge (1).

The status of currently available data: Unfortunately, there have been fewer data reports evaluating water quality published in recent years. In Germany, the responsibility for surveys and publications lies largely in the realm of each of the federal states, and many publish only what is required by (EU) law or in response to enquiries submitted to state parliaments. Some states, such as Rhineland-Palatinate and Brandenburg, have published almost no current information within the past ten years. Significant gaps also exist in the data obtained from the monitoring of tap water. Moreover, changes/reductions in the scope of the data collection points prevent a comparison of the recorded data. Furthermore, the minimum frequency of tap water analyses will be reduced by individual, generally less extensive sample collection regimens in the future. In some cases, countries no longer evaluate the data collected, instead making them available only in the form of data banks, which are also known as “data graveyards”.

Uniform and precise regulations to comprehensively monitor water quality throughout the entire country are urgently needed at the federal and state levels of government in Germany. In addition, these results should be published in a structured format.

Key results for 2022: The risk to water quality remains quite volatile. In this regard, nothing has fundamentally improved since the release of the first Black Book on Water, published by the Qualitätsgemeinschaft Bio-Mineralwasser in 2017. Indeed, quite the contrary is true:

1. The level of nitrate contamination is essentially unchanged. Relief, which was initially anticipated from the decommissioning of particularly contaminated wells and reduced amounts of nitrogen being deposited into the subsoil, is hardly apparent in the measurement results due to years of drought.

2. Recent soil surveys have shown for the first time ever the enormous extent of groundwater contamination through pesticides and their degradation products. The situation is already grave, and it will only get worse. Exposure to these pollutants is a danger to living organisms and is getting worse as time goes on.

3. Contamination with man-made pollutants is reaching ever greater depths in groundwater reservoirs.

4. Currently, in addition to agricultural pollutants, groundwater and tap water are especially threatened by perfluorinated chemicals and drug-residues.

5. A truly comprehensive and regional assessment of the state of water with a uniform database for all federal states in Germany does not exist.

6. Now, more than ever, it is essential that the total area of organically farmed land, i.e., farmed without artificial fertilizers and pesticides, is expanded in order to protect water quality.

1. Germany – Nitrate

(database source no. 2)

1.1 Data, current state of knowledge

EU law requires Germany to submit a report every four years on the status of nitrates in groundwater. This is based on a representative "EEA data collection network" (EEA = European Environment Agency) which consists of 1,200 points of measurement. A subgroup was formed to gather data from 692 measurement points, representing only the agricultural catchment areas and referred to as the "EU nitrate monitoring network". The most recent data on this were collected between 2016 and 2018 and were published by the Federal Ministries for the Environment and Agriculture in Germany.

1.2 The status of nitrate in groundwater

According to the 2020 Nitrate Report, **26.7% of all data collection points** in the "EU nitrate monitoring network" exhibited nitrate concentrations in excess of 50 mg/l, which is above the allowable limits for tap water. In the German EEA nitrate data collection network, i.e., spanning the entire country, including forest and nature reserves, etc., similarly contaminated groundwater and drinking water was found at 17.3% of data collection points. Over the preceding period, from 2012 and 2015, these figures were 28.2% and 18.1%, respectively.

However, a detailed analysis shows that the decline is mainly due to the omission of a few data collection points where extreme contamination is present (> 100 mg/l). Overall, the situation has remained almost unchanged. This has been exacerbated by the fact that 2018 was a particularly dry year. This means the majority of the nitrate has been retained in the topsoil and has not yet migrated into the groundwater.

Compared to previous reports on the presence of nitrate, these data were no longer categorized into groups according to the individual states in Germany, which makes the data less transparent and unnecessarily complicates efforts to compare and analyze developments occurring in different regions.

2. Lower Saxony

(database sources nos. (3) to (5))

2.1 Nitrate

Unfortunately, no current data has been published for the nitrate levels in the groundwater of Lower Saxony. Therefore, it is not possible to ascertain whether the contamination levels of groundwater have dropped. It is conceivable that some relief has arisen from the sharp increase in exports of manure and fermentation residues. According to a response provided by the Ministry of the Environment to a request for information submitted by the Bündnis 90/die Grünen (the Green Party of Germany), these exports increased from 1.28 million metric tons in 2015/16 to 1.89 million metric tons in 2019/20. Around 40% of the manure from Lower Saxony was exported and applied to fields in North Rhine-Westphalia (3).

2.2 Pesticides

Lower Saxony is a leader in pesticide monitoring with a project that is unique within Germany. Conducted by the Lower Saxon State Department for Waterway, Coastal and Nature Conservation, the goal of the project is to monitor the contamination of groundwater with pesticides and their degradation products (4) over the long term. Due to the lengthy period required for these substances to reach aquifers, the enormous scope of this contamination process can only be mapped with a large number of defined measurement points combined with analyses over this period. This included 5,781 measurement points, from which 1.3 million individual analysis values were obtained in the years spanning 2000 to 2016. This immense amount of data was evaluated at the district level and compared to the respective land management practices. The results have shown disastrous levels of contamination: Not only were 348 different active components of pesticides but also 28 relevant and 39 non-relevant metabolites, i.e., degradation products of these active substances, recorded analytically for the first time. Of the 415 different substances covered in the study, **164 substances had already been detected in the groundwater**.

Pesticides and their degradation products were detected **at 60.9% of all the data collection points**. Except for a few areas on the coast and in the eastern part of the country where conventional agriculture is not as common, the country is affected across the board by the contamination of water with pesticides. At 14.3% of all the data collection points, active pesticides and relevant metabolites were detected, including contamination with a significant proportion of substances which have long since been banned. Non-relevant metabolites (nrMs) were found at 58.1% of all the data collection points. The maximum concentrations measured were also quite concerning, some as high as 7.9 µg/l for active substances (the limit value specified in the *Trinkwasserverordnung* (TWVO, German Drinking Water Ordinance) which should be no higher than 0.1 µg/l). The value for nrMs was measured at 35.0 µg/l (unfortunately, there is no requirement concerning the legal limit currently in place for tap water).

The large number of active substances detected, some of which have been banned for decades, demonstrates the extremely long-lasting and slow influx of these pesticides into groundwater. In particular, the steadily increasing use of glyphosate over approximately the last 20 years in agriculture is now becoming apparent in groundwater. Despite the fact that detection of these substances is not widely practiced, it already occupies second place on the list of approved pesticides detected in this study.

It is not surprising that water wells up to 30 m deep are particularly affected by contamination with these substances. This is the reason why nrMs can be detected at 67.3 % of the data collection points in this category. But wells which are deeper than 80 m are already showing a massive incidence of contamination: nrMs can presently be detected in 21 % of wells at this depth.

Particularly noteworthy is the data correlation between certain substances detected and the type of land management. For example, the map below shows the incidence of detection of S-metolachlor sulfonic acid (metabolite CGA 380168/CGA 354743), a degradation product of the active substance S-metolachlor, together with the proportion of land used to cultivate corn (maize) in 2011. The areas depicted in red are those in which the percentage of corn cultivation ranges from 20% to more than 40%. The points show the different concentrations of this metabolite detected in the groundwater. S-Metolachlor is a pesticide typically used for growing corn.

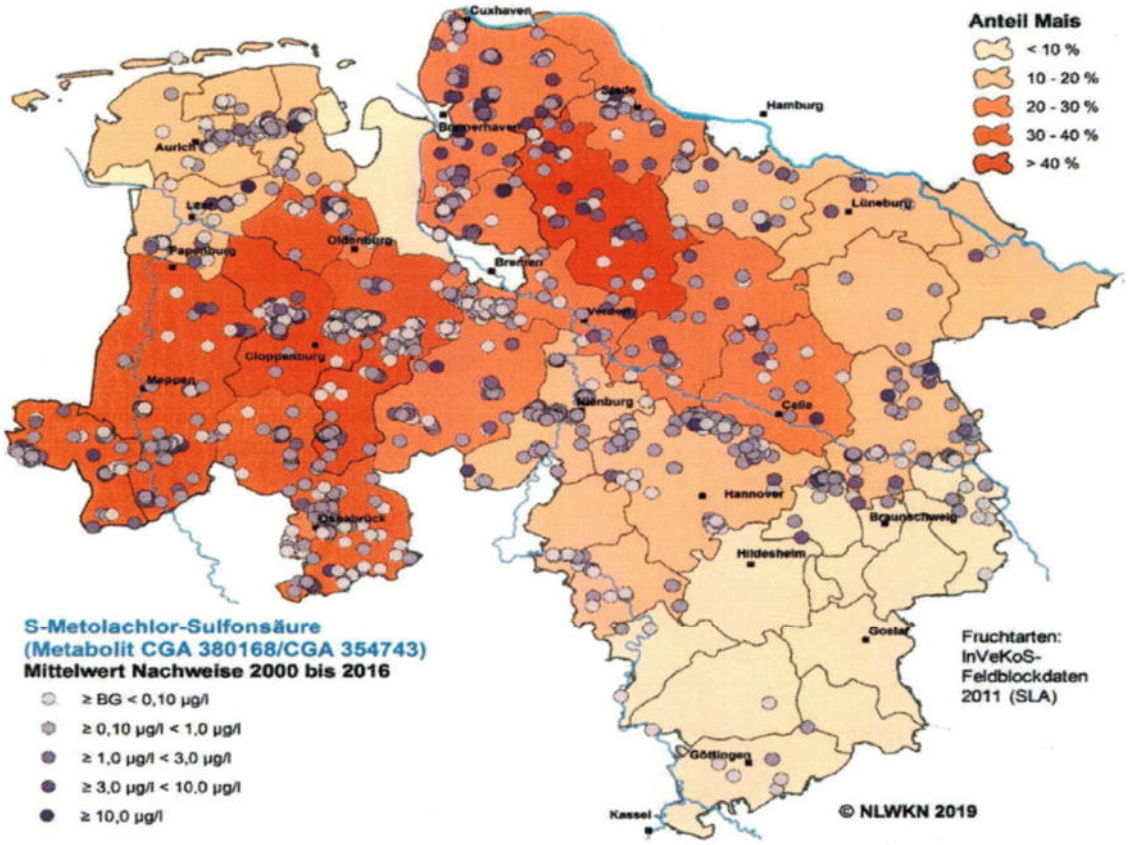

Abb. 6-9: Karte mit Mittelwerten der Nachweise von S-Metolachlor-Sulfonsäure 2000 bis 2016 an Einzel-Messstellen in Kombination mit dem Anteil der Fruchtart Mais auf Betrachtungsebene Land-kreise

The same correlations were observed between the degradation product of a typical pesticide associated with growing sugar beets and the proportion of land used for sugar beet production, as well as the degradation products of a typical pesticide employed in rapeseed cultivation and the proportion of land used to cultivate this crop.

Lower Saxony draws about 85% of its tap water from groundwater. Individual examples of the consequences of this groundwater pollution on tap water production were described in the study outlined above, which was performed by the Lower Saxon State Department for Waterway, Coastal and Nature Conservation. This is exemplified in two case studies in which blending heavily contaminated groundwater with less contaminated water in order to comply with the limit values was no longer possible. This means the costs associated with purifying the water will be passed on to members of society. The Wasserwerk Weener (Weener water utility) and the collective municipality of Hoya had to build large, activated carbon purification plants to properly purify the contaminated water. By spreading the investment costs over a period of ten years coupled with the ongoing operating expenses, this amounted to a permanent rate hike of around 25 cents per cubic meter of tap water. This additional expense is borne by the consumers who are affected by the contamination, not those who were actually responsible for polluting the water in the first place.

Due to the extent of the data collected, a forecast could be made for the behavior of nine selected substances. Depending upon the pesticide, the amount of groundwater contamination expected for each substance may increase or decrease; however, it is feared that contamination with nrMs will continue to increase over time, in some instances, with significant spikes in concentration.

These fears are further underscored by the recent figures for pesticide sales in the Federal Republic of Germany for the year 2020 (5). According to the Federal Office for Consumer Protection and Food Safety the number of approved pesticides is now at an absolute high at 980. **And at a total of 48,002 metric tons, the sum of active ingredients is close to the all-time high which occurred in 2017** (based upon a comparison of the years since 1992). In particular, the application of substances which are more harmful to groundwater (and also more harmful to insects) has increased. The short-term declines in 2018 and 2019 were probably attributable to the extraordinary drought conditions present during those years.

3. New scientific findings on the harmfulness of pesticides

A large-scale pilot study conducted by the Helmholtz Centre for Environmental Research (6) focused on the environmental impact of pesticides and showed that even low pesticide concentrations can cause massive damage to sensitive aquatic organisms and insect species, such as dragonflies. The researchers are calling for a revision in how pesticides are monitored and approved. The regulatory acceptable concentrations (RAC values) established by the state are usually too high, with concentrations exceeding even these high values in more than 80% of the water samples analyzed.

A recent Swiss study (7) pointed out the harmful nature of pesticides on organisms living in the soil and the root fungi that exist symbiotically with plants. By comparison, the number of pesticides in fields cultivated using conventional agricultural methods was twice as high as in those growing crops according to organic methods. Furthermore, the concentration of pesticides was nine times higher in conventional versus organic fields. The reason pesticides can be detected in the soil of organic farms is due to the long period required for the pesticides from previous applications to degrade or migrate into the groundwater.

Comments from the Qualitätsgemeinschaft Bio-Mineralwasser:

As the authors of the study from Lower Saxony describe the replacement of pesticides with mechanical and non-chemical agricultural methods is the safest way to protect groundwater against contamination. Thus, organic farming, which precisely employs such methods, does not rely on synthetic fertilizers and places limits on animal husbandry, offers **the only comprehensively effective method for protecting the purity of groundwater**. However, the figures determined in 2020 showing a 10.3% share of organically cultivated land in Germany and a 5.2% share of the same in Lower Saxony, are far too low to ensure the overall protection of water purity in Germany (8).

At the same time, new scientific studies have shown how long it realistically takes to clean up fields which were cultivated with conventional methods until they can once again be considered suitable for organic agriculture. Nevertheless, when it comes to tap water, consumers are not in a position to choose whether they drink water which is free of pesticides or not. The only feasible solution is to actively protect the water across the entire country and to motivate the companies who package and sell water products from wells to become “organic water farmers” as do those who belong to the Qualitätsgemeinschaft (quality association) in their regions: one of the key points in doing so is to enable farmers to make it a financially feasible for farmers to adopt organic farming. This must begin immediately in watershed areas.

4. Bavaria

(database sources nos. (9) to (18))

It is also no simple task to find the direct correlations in the data published by the state of Bavaria. On one hand, there is an entire data collection network for groundwater quality encompassing 742 measurement points. This seems to be the basis for the information provided by the state government in 2021 regarding the status of groundwater in the individual administrative districts (12 to 18). In addition, within the scope of the implementation of the EU Water Framework Directive, there is the WFD surveillance network with 485 data collection points, which forms the basis of the reporting done by the *Landesamt für Umwelt* (Bavarian Office for the Environment) (9).

4.1 Nitrate

According to the analysis data, the nitrate concentration in raw water (untreated water from groundwater or surface water sources) and groundwater containing nitrate has remained at a constantly high level for roughly the past ten years. However, about 200 water wells were decommissioned due to the high concentrations of nitrate in the untreated water, which contributed to this result from 2000 to 2018. This means that the nitrate status of the water has actually deteriorated.

- Raw water

  In 2018, 19.9% of the water used for the production of tap water in the state of Bavaria exhibited nitrate levels of 25 mg/l, while 3.4% of the samples even exceeded the allowable limit of 50 mg/l for tap water. These are almost identical to the values reported in 2012 (9). The regions posting the worst values in 2018 were the Upper Palatinate with 34.0% of the samples collected containing above 25 mg/l nitrate, with 7.4% exceeding the 50 mg/l limit, and Lower Franconia, at 50.1% and 18.4%, respectively. Significant increases have occurred since 2012 (10).

- Groundwater

  Water analyzed at 38.2% of the data collection points across Bavaria contained nitrate concentrations in excess of 25 mg/l in 2018. Compared to the figures from the beginning of the decade, this number increased by one-third. The proportion of data collection points found to contain nitrate concentrations **in excess of 50 mg/l was 10.2% in 2018 – almost double** the values reported in 2010. The districts of Lower Franconia, Middle Franconia, the Upper Palatinate and Lower Bavaria were the most impacted (9). The questions submitted by the Green Party (Die Grünen) to the Parliament over the course of 2021 showed – apparently based on the larger overall monitoring network – 192 points throughout Bavaria where measurements yielded nitrate values above 37.5 mg/l (which corresponds to 25.9 % of all the data collection points). Of these, 137 points were located in the four regions mentioned previously. At the top of the list was a sample with a nitrate content of 130 mg/l ((12) to (18)). At the county level, certified analysis results clearly show a concentration of such samples in areas where intensive conventional land management is practiced, and where the density of livestock and biogas plants is high.

In the past, biological reduction processes occurring in the soil lowered the amount of nitrate that was carried to deeper levels of the soil. The LfU also notes that the substances present in the soil which are necessary to perform reactions are increasingly being depleted. After they are fully

depleted, the soil will no longer have the capacity to degrade nitrate, therefore rising levels in the concentration of nitrate in groundwater should be expected (9).

This means that the options available to water utilities, which will allow them to adhere to the legal limits for nitrate concentrations, are becoming more limited or very expensive, e.g., decommissioning wells with strong contamination levels or installing treatment plants to remove nitrate. For this reason, pressure is mounting on the state government to allow development of new wells to draw water from pristine deep aquifers. So far in Bavaria, this has only been allowed for the higher purposes of human health and nutrition. Furthermore, hydrogeologists are reporting incidents of pollution of existing deep wells which are used to supply tap water. They have often been contaminated with surface water through a "hydraulic short circuit" due to improperly constructed deep well systems. This has ultimately led to their contamination (11).

4.2 Pesticides

- Raw (untreated) water

  In 2018, pesticides were detected in 22.5% of the water used for the production of Bavarian tap water. 2.3% of the samples exceeded the limit value of 0.1 µg/l which applies to drinking water. Here, one sees again that the areas where intensive agriculture is practiced are particularly affected. Almost 40% of the raw water in the Upper Palatinate, Middle Franconia and Lower Bavaria is contaminated. Significant increases have been posted in Lower Bavaria in recent years as well.

- Groundwater

  For the data collection period of 2017/18, pesticides were detected at 34.1% of the points. 7.7% of the measurement points exhibited values above the maximum allowable values of 0.1 µg/l for pesticides. Where these measurements were taken, the values are down from 2011/12 at 43.1% and 10.5%, respectively. In particular, the presence of pesticides which have been banned for decades, such as atrazine and bentazon, are detected less frequently now than they were in the past.

4.3 Non-relevant pesticide metabolites

Analytical data regarding the non-relevant metabolites of pesticides in groundwater are not evaluated in the reports created by the Bayerische Landesamt für Umwelt (Bavarian State Office for the Environment). Since the questions submitted by the Green Party to the Bavarian State Parliament in 2021 also covered these substances, the responses given by the state government of Bavaria provide an initial overview of groundwater contamination with these substances. Since the request for information only encompassed analytical results, which are higher than a value of 0.1 µg/l but did not specify the detection of these substances in general, these results are lower than those collected in other areas, e.g., in Lower Saxony and Baden-Württemberg.

For instance, nrMs were measured in concentrations of more than 0.1 µg/l at 320 data collection points across the state. Based upon the overall network subject to analysis, this would correspond to 43.2% of all the points where the measurements were taken. In the process, peak concentrations as high as 13.0 µg/l were measured for up to 11 different nrMs simultaneously. Areas of intensive agricultural production, particularly Lower Bavaria, are localized hotspots of water pollution ((12) to (18)).

Comments from the Qualitätsgemeinschaft Bio-Mineralwasser association:

Increasingly, utilities that supply tap water are exhausting their options by using methods employed previously to comply with limit values. These methods include decommissioning heavily contaminated wells, lowering concentrations of harmful substances by blending with groundwater with lower levels of contamination, or purifying the water with inordinately expensive equipment. Therefore, the simple "solution" under discussion – namely to tap into the last pristine deep groundwater reserves and to exploit it indiscriminately, e.g., as water to flush toilets, for other sanitary applications, or for cleaning and industrial purposes, is anything but sustainable for future generations – and as such is completely out of the question. When considering the legacy for future generations, it would be irresponsible to "consume" this water for the trivial applications stated above or to utilize it to irrigate fields which have been contaminated with agricultural chemicals.

There is no sustainable solution other than to actively bring about significant change in the approach to land management and animal husbandry. This is why the Qualitätsgemeinschaft Bio-Mineralwasser promotes organic farming methods and shares its competence with all interested water utilities, fostering collaborations or supporting them in their events. A number of relevant collaborations are already in existence.

5. **Baden-Württemberg**

(database sources nos. (19) to (20))

Following a longer break, in April of 2021, the Landesanstalt für Umwelt Baden-Württemberg (State Institute for the Environment of Baden-Württemberg) published another report with the results of the groundwater monitoring program for the years 2018 and 2019. These reports have been available in this form, only from this state, since 1991. They have been regularly evaluated by the author since the late 1990s.

Moreover, the following data were obtained from the LUBW-Beschaffenheitsmessnetz (quality monitoring network), which encompasses 1,866 data collection points (as of 05/2020) and is unique in Germany. This is complemented by data obtained from water utilities from a further 1,300 to 1,900 data collection points, mainly from water in protected areas. The quality of the data and their scope provide an excellent overview of long-term changes in the quality of the groundwater.

5.1 Nitrate

In 2019, 8.8% of all data collection points of the LUBW-Beschaffenheitsmessnetz were above the limit value of 50 mg/l for nitrate. 17.8% of all the points were above the critical value of 37.5 mg/l nitrate. After reaching the respective peaks of 10.2% and 20.7% in 2013, the values have declined slightly.

A separate sub-network for measurements "Landwirtschaft" (Agriculture), from which urban and natural areas are calculated, **showed that 18.5% of the data collection points were above the limit**

value and 33.2% were above the critical value. Compared to previous years, these data have remained almost unchanged.

One should bear in mind that 2015 and 2018 were extremely dry years, and the groundwater supplies were not fully replenished during the year 2019. The nitrogen stored in the soil in dry years is released in subsequent years with additional precipitation. The water percolating through the soil carries the nitrogen into the groundwater. This nitrogen will then be present in the water and detected in the analyses conducted over the following years.

5.2 Pesticides

Traces of pesticides and their relevant metabolites were detected at 14.5% of the 1,866 data collection points; concentrations as high as 4.5 µg/l were recorded. First and foremost, substances which have been banned a long time ago, such as atrazine and desethylatrazine, were found in the samples analyzed. According to LUBW, the results indicate a trend that these substances are declining. So, the ban is starting to have the intended effect. However, it would be advisable for the LUBW to include other pesticides that are currently in widespread use, such as glyphosate and chloridazon in the scope of their analysis. If this were implemented, it could easily reverse this positive trend, making it apparent that further restrictions on the application of pesticides are necessary.

5.3 Non-relevant metabolites

From 2017 to 2019, 11 pesticide degradation products designated as "non-relevant" metabolites were analyzed in samples collected at approximately 1,866 data collection points. In total, these substances were detected at **63% of all data collection points**. This is on a similar order of magnitude compared to Lower Saxony, although important substances, such as the non-relevant metabolite of chlorothalonil present in the groundwater were missing in the scope of analysis for Baden-Württemberg.

The substances which were detected are clearly attributable to the agricultural activity in the region. Whether it is sugar beet farming near Heilbronn or wine, fruit and hop cultivation on the Upper Rhine plain, the central Neckar area or around Lake Constance, these non-relevant metabolites are closely related to the conventional, intensive agricultural practices specific to each crop.

5.4 Artificial sweeteners

For a number of years now, in addition to problem substances related to agriculture, the LUBW has been investigating a wide range of residues of industrial origin in groundwater. Since 2015, groundwater samples have been tested for the presence of artificial sweeteners to determine the influence of wastewater on groundwater. A total of 1,908 data collection points were evaluated from 2015 to 2019. Artificial sweeteners were found **at 47.6% of the data collection points**, with acesulfame being the most frequently detected.

These results demonstrate the degree to which the state of groundwater over a large area is now considered to be critical. The safety of these artificial sweeteners should be tested for their impact on human health. However, the fact that they are already present in the groundwater points to the strong possibility that our water resources have already been contaminated with other substances which are already viewed as very questionable in terms of human health.

5.5 Perfluorinated and polyfluorinated chemicals

PFCs, as they are known, are at the top of the list of these critical substances. These substances are assessed as highly critical, because they accumulate in living organisms and are toxic as well as carcinogenic. For humans, tap water is considered the primary source for the ingestion of these substances.

Starting in 2026, the presence of PFCs in tap water must be uniformly monitored throughout the EU. At that time, the full extent of the contamination will be revealed. The LUBW has analyzed PFCs in groundwater since 2015. This effort is fueled by the largest German pollution scandal in history which involved the contamination of groundwater in the districts of Rastatt and Baden-Baden (20). Around 100,000 m^3 of PFC-contaminated compost was “dumped” on land, which was cultivated using conventional agricultural methods, contaminating not only the soil but the underlying groundwater as well. Total remediation of 1,188 hectares in Mittelbaden alone would have come at a price of € 3.3 billion. In order to avoid the costs of such a remediation, those in charge of water utility companies chose to rely instead on activated carbon filters, which at least remove the majority of the contaminants, but this has increased the price of water by € 0.58/m^3.

Residents who drank this “filtered” tap water showed high PFC concentrations in their blood in 2018 and 2020. These concentrations declined again after drinking uncontaminated mineral water or tap water which has undergone additional purification.

Yet the problem has long been present over a wide area, which was evident in the analysis results compiled by the LUBW. PFCs were detected in 45.2% of the 1,913 data collection points evaluated. This means that this hazardous substance has long since reached the groundwater over a large area. Starting in 2026, there will not only be regulations that require analysis for the most important PFCs, but there will also be a total limit value of 0.5 µg/l imposed.

Comments from the Qualitätsgemeinschaft Bio-Mineralwasser:

The comprehensive, wide-ranging analyses conducted by the authorities in Baden-Württemberg show how urgently a comparable program is needed throughout Germany. Even in the model state of Baden-Württemberg, however, the analysis of many substances is still lacking. This shows how false the statement is – which has now been legally banned – that tap water has always been the most closely monitored comestible.

Even without the availability of well-prepared data to facilitate comparison, it is not to be expected that the water situation in other federal states is better than in Baden-Württemberg. This calls for even more urgency because the current options in the hands of water utilities to treat tap water are limited to the removal of just a few pollutants and becomes more expensive as time passes.

Back in 2015, the Qualitätsgemeinschaft Bio-Mineralwasser took measures to introduce a limit value of 0.02 µg/l for each individual substance.

This still does not solve the problem: We must use all the options available to us to reduce the amount of these contaminants being released into the environment. In addition to adopting and implementing organic farming practices, the use of all substances, which are known to pollute water, must be prohibited.

The following data show the extent to which various problems in groundwater and surface water are already affecting the purity of tap water.

6. The quality of tap water in Germany

6.1 Report compiled by the BMG and UBA on deviations from limit values
(database source no. 21)

Due to an EU requirement, the federal government must report all deviations from the legal limit values as stipulated in the regulations governing drinking water in Germany. The report is submitted every three years. This report addresses only larger water supply systems from which more than 1,000 m^3 of tap water is drawn per day. According to the BMG and the UBA report for 2019, the most recent year documented, 4.70 billion m^3 of water were distributed from 2,485 water supply areas to 73.1 million residents.

Monitoring tap water

First, the report (pp. 7 and 14) states that the tap water from each of the supply areas must be analyzed a minimum of **nine times annually** (routine analysis must be conducted seven times in addition to two comprehensive analyses). This number may be halved under certain conditions. For a product that claims to be “the most closely monitored comestible”, this is a very modest degree of monitoring.

Moreover, even these prescribed minimum frequencies for analysis in 2019 were not carried out at 352 sites, i.e., 14.2% of the areas were not subjected to analysis to the extent they should have been

(p. 16); of these, 9.9 million people were affected. While the analytical specifications of the microbiological parameters were upheld to some extent, the analysis of some of the chemical parameters, such as lead, nickel and pesticides, is insufficient. These parameters are only regulated by law within a narrow scope and the specified frequency of analysis for monitoring purposes was not fulfilled by a number of water supply areas (pp. 18 to 23), though the differences between the federal states are significant. The states of Rhineland-Palatinate, NRW and Mecklenburg-Western Pomerania stand out as particularly problematic.

Compliance with limit values

Since it is difficult to impossible to supply the population with the large quantities of tap water necessary for households without depending upon a network of pipes, disrupting the flow of water through such systems only occurs if there is a threat of a direct hazard to human health through chemical contamination or an immediate threat to human health due to the presence of pathogens in the water (§9 (3) TWVO, German Drinking Water Ordinance). **Exceeding limit values, even if it causes long-term damage to health, does not lead to an interruption in the supply of water**. § 10 of the TWVO regulation states that a maximum of three deviations from the limit values for chemical parameters are allowed within a time period of three years (p. 37). **This is usually not general knowledge within the population – most people assume that the limit values for the analysis parameters must be in constant compliance with the legally set limits.**

Based on the language found in the legal provisions for tap water, it does not appear that the goal of this legislation is to ensure a particularly high water quality.

The population affected by failure to comply with limit values

Reports on the extent to which the population in Germany is affected by non-compliance with limit values provide valuable insights into this problem. A number of incidences from 2019 are included below (p. 42):

- exceeding the limit for coliform bacteria – 12.2 million people affected.
- exceeding the allowable number of bacterial colonies – 2.6 to 2.9 million people affected.
- exceeding the limit for lead – 293,000 people affected.
- exceeding the limit value for nickel – 201,000 people affected.
- exceeding the limit for pesticides – 72,000 people affected (data from 2018).

The low number of people supposedly affected by pesticide residues is not surprising in view of the very limited scope of analysis. No analysis – no concern.

6.2 Evaluation of media publications 2020-2021
(database sources nos. (22) to (23))

In addition to continuously monitoring publications and databases on water quality, the Qualitätsgemeinschaft Bio-Mineralwasser e.V. also keeps tabs on media reports in Germany on the topics of water and sustainability. These reports in 2020 and 2021 were systematically evaluated and yielded an interesting picture of the current issues concerning tap water in Germany.

Evaluation of media contributions in 2020 (22)

In 2020, a total of 218 reports on problems associated with tap water were recorded.

- 49.5% of the reports concerned Bavaria, 18.4% Baden-Württemberg, with the remainder distributed among the other federal states. The reason is likely to be in the small-scale structures located in the southern part of Germany with water supply systems in great need of overhauling and updating.
- Of these, 182 reports, i.e., 83.5%, documented microbiological problems with tap water, 14.7% dealt with chemical issues, and 1.8 % concerned supply shortfalls.
- In 28.9% of the reports, problems with piping and tall containers were identified as the causes, 6.4% were related to issues with natural springs and wells. In 64.7% of the reports, either no reasons were given, or statements were made indicating that it was very difficult to establish the cause of the problem.
- In 182 reports, the authorities responded to the problems by issuing boiling notices to the public, treating the water with chlorine or directly banning the use of tap water altogether for a certain period. In addition, eight reports stemmed from microbiological problems, which would have required hygiene measures or investment. These only made up 4.4 % of the cases reported.

Boiling water prior to usage or treating the water with chlorine offer simple and inexpensive solutions. For this reason, these represent the ideal solution if water utilities want to avoid expensive investments in treatment plants and distribution networks. As a rule, when making announcements to consumers, they are informed that the treatment of water with chlorine is "completely harmless". At the same time, however, they are often advised that the chlorinated tap water is not suitable for fish in aquariums. It is known that certain species of fish are sensitive to poisons and therefore act as indicators for the presence of toxic substances in water. For this reason, those with an aquarium are offered water at a special dispensing point where they can receive water safe for fish. This certainly draws attention to the claim that water treated with chlorine is harmless.

Of the 32 chemical-related reports, seven samples of water contained of perfluorinated chemicals, while six reports were submitted for manganese and five for nitrate. These were made due to the values exceeding legal limits. Reports of pharmaceutical residues, too much nickel or lead and pesticide residues were the exception, which has to do with the fact that these substances are rarely analyzed as frequently as legally prescribed or when they are analyzed, only a few of the results are recorded.

<u>Evaluation of media contributions in 2021 (23)</u>

A total of 203 reports on problems with tap water were recorded in 2021.

- Again, Bavaria was in the lead with 47.3 % of the reports; 18.8% were in Baden-Württemberg. NRW and Hessen each had 8.9% of the reported instances followed by Rhineland-Palatinate with 4.5%. Surprisingly, there were two states which cover significant areas, Saxony-Anhalt and Schleswig-Holstein, without a single report.
- Almost all reports (95.1%) were related to microbiological problems in tap water. Chemical problems were almost no longer worth reporting to the media in 2021.
- In 26.6% of the reports, issues with water distribution lines were identified as the cause, in 11.4% of the reports, problems with tall containers are named. This was followed by 10.6% of the reports for impurities in the water from natural springs and wells. Heavy rain and flooding were listed as the causes in 12.4% of the cases.
- Microbiological troubles were addressed through chlorination of the water in 61.7% of the cases. In 58.6% of the cases, a mandatory notice to boil tap water was issued while a mere

recommendation to boil the water was made in 15.6% of the cases. There were direct bans on the utilization of drinking water in seven cases, and in six instances, a recommendation to drink mineral water was given.

The floods in July of 2021 led to unmanageable microbial contamination of the tap water and to innumerable reports of water problems. The county of Ludwigsburg in Baden-Württemberg announced that the limit values had been exceeded 26 times (24), approximately five times more than the number of times reported by the media. This raises suspicion that a much higher number of unreported cases may be hidden behind the official number of 203. Furthermore, there was a noticeably high number of complaints from citizens about missing or insufficiently detailed information in 2021.

The high concentration of reports in northern Bavaria sheds light on the statement issued by the Bayerische Gemeindetag (Bavarian Association of Municipalities) (25). There is a great need for investment in this area as a result of the neglect of the water supply systems in the past.

7. A brief digression regarding urban settings: Berlin

The Berliner Wasserbetriebe (water utility of Berlin) is one of the few water utilities in Germany that for years – without any legal or official requirement – has voluntarily analyzed its tap water for a broad range of detectable residues and publishes the mean values separately for each of the nine Berlin waterworks, in an exemplary manner (26).

In contrast to previous publications, however, the scope of the pesticides analyzed has been reduced in recent publications. Furthermore, at the end of 2021, the data for the year 2020 had still not been published for two of the waterworks.

In contrast to large areas of Germany, the Berlin water supply has no problems with agricultural residues. Pesticides and their degradation products are not detectable in the water in Berlin, and the nitrate levels are consistently below 5 mg/l. Therefore, the water quality would, at first glance, seem to be in compliance with the values specified in the TWVO regulations.

However, it is not atypical for water extracted from areas near the surface in large cities to contain a broad range of industrial chemicals, active ingredients from pharmaceuticals and their degradation products. Six waterworks in Berlin are affected by industrial chemicals. The tap water contains residues of surfactants, anti-corrosion agents, particularly the facility that supplies water to the center of the city. It is particularly striking that the high concentration of EDTA, a cleaning agent and disinfectant was measured at 11 µg/l at the Tiefwerder waterworks. This was the first time ever that the so-called “health orientation value” (Gesundheitliche Orientierungswert, GOW) of 10 µg/l was exceeded for this substance. However, this very GOW was abolished in 2020 by the Umweltbundesamt (Federal Environment Agency) so that no consequences were levied for exceeding the limit.

The detection of pharmaceutical substances has increased slightly, which is also attributable to improved analysis methods. The spectrum of substances detected ranges from zero in the rural Kaulsdorf facility **up to 19 different substances in the Tegel waterworks**. In a total of five waterworks, in Beelitzhof, Friedrichshagen, Kladow, Tegel and Tiefwerder, the number of substances is in the double digits, while in two waterworks, Tegel and Friedrichshagen,

concentrations of 50% of the individual substances, such as phenazone, oxypurinol, etc., exceeded the GOW values. This reveals the extent of the problem. GOW values are only defined for a small portion of the substances that are detected, and they also do not take into consideration the consequences of ingesting a number of these residues simultaneously.

In order to counteract the problem, various water treatment procedures have been tested in Berlin over the years. At a cost of € 48 million, the Schönerlinde sewage treatment plant is currently the first large plant to be retrofitted so that at least a significant proportion of these residues can be removed from the water processed there. The plant is scheduled to begin operation at the end of 2023. The remaining sewage treatment plants are also scheduled to be retrofitted by the mid-2030s. Then it will take several decades for the positive effects to be detectable in the tap water (27).

Until recently, the Berliner Wasserbetriebe made no secret about it on their website, clearly displaying the quote: “Generally, it is not possible to have drinking water that is completely free of chemical residues, and in particular, the removal of pharmaceuticals for humans is practically impossible.” Citizens were urged to recognize this fact. On the current website, unfortunately, this accurate notification has been removed. Ultimately, it remains the decision of each individual resident of Berlin, as to whether they want to enjoy this cocktail of residues directly from the tap every day.

Comments from the Qualitätsgemeinschaft Bio-Mineralwasser:

To date, no drug residues have appeared in natural mineral water. However, given the nature of the water cycle, it is highly probable that it will do so at some point in the future. Today, the guidelines set forth by the Qualitätsgemeinschaft Bio-Mineralwasser already require that organic mineral water meet the strict limit value of 0.02 µg/l for drug residues.

Due to the limited effectiveness and the increasingly apparent, higher costs, all of the “end-of-the-pipe solutions” involving the expansion of water purification systems only make sense to a limited degree. It is essential that pollutants are prevented from entering the water cycle in the first place.

CONCLUSIONS AND DEMANDS

1. In light of deeply concerning changes in the quality of the groundwater in Germany, pollutants must be prevented from coming into contact with water as soon as possible.

    a. To this end, agriculture located in the catchment areas for drinking and mineral water reserves must be converted to organic farming operations in a financially sustainable manner as soon as this is feasible.

    b. This requires long-term, reliable support for these farmers. Society must be willing to pay a reasonable price to ensure that it receives good water.

c. Furthermore, the introduction of pesticide agents into the soil and the water must be reduced in general. To achieve this purpose, it follows that the companies who are responsible for producing these pollutants should share the cost incurred through the application of these products in the form of a supplemental tax.

2. However, water must be protected across the country. The federal government of Germany is actively pursuing its goal to have 30% of the farmland cultivated organically by 2030. But conventional agriculture must also protect the environment by abandoning the use of chemical pesticides and switching to mechanical and non-chemical methods.

3. Lowering the concentration of nitrate in the water requires a reduction in the application of manure and fermentation residues. This is not possible without reducing intensive, large-scale livestock operations. The number of animals to be kept must once again be bound by the area available to properly support the animals.

4. There is a lack of information on the quality of water. The federal government must introduce uniform and precise regulations to achieve comprehensive monitoring of water quality all over Germany with provisions for the structured publication of the results.

5. Pristine, uncontaminated, deep groundwater resources, some of which are often very old, must be preserved for future generations – for the grandchildren of the present generation. Its current use must be limited to high quality applications which benefit human health and nutrition.

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ABBREVIATIONS

- GOW = Gesundheitlicher Orientierungswert des Umweltbundesamtes (not a limit) (health orientation value)
- EU = European Union
- EUA = Europäische Umweltagentur (European Environment Agency)
- LfU = Bayerisches Landesamt für Umwelt (Bavarian Office for the Environment)
- LUBW = Landesamt für Umwelt Baden-Württemberg (Office for the Environment Baden-Württemberg)
- nrMs = non-relevant metabolites (PSM degradation products with a lower toxicity than the PSM)
- NRW = North Rhine-Westphalia
- PFC = perfluorinated and polyfluorinated compounds
- PSM = pesticide agent (including the relevant metabolites)
- raw water = untreated water collected from various sources prior to treatment at a water utility
- TWVO = *Trinkwasserverordnung* (German regulations governing the purity of water for human consumption)