International Commission for the Hydrology of the Rhine Basin (CHR)

2024 Annual Report of the CHR

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*Photo on cover page***:** Lower Rhine (Emscher estuary 2013)
Photo by: Roy Frings, Rijkswaterstaat

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Internationale Kommission für die Hydrologie des Rheingebietes
International Commission for the Hydrology of the Rhine Basin

The International Commission for the Hydrology of the Rhine Basin (CHR) works within the framework of the Intergovernmental Hydrological Programme (IHP) of UNESCO and the Hydrology and Water Management Programme (HWRP) of the World Meteorological Organisation (WMO). It is a permanent, independent, international commission and has the status of a foundation registered in the Netherlands. Members of the commission include the following scientific and operational hydrological institutions of the Rhine basin:

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- Office of the Vorarlberg State Government, *Water Management* Division, Bregenz, Austria,
- Federal Office for the Environment, Bern, Switzerland,
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1.1 Meteorological Characteristics

1.1.1 Austria

Source: GeoSphere Austria, Austrian Service for Geology, Geophysics, Climatology and Meteorology

Temperature
In many respects, the temperature trend in 2024 has surpassed anything previously seen in Austria's history of temperature measurements. On the one hand, the generally extremely high global temperature levels across the country resulted in consistently significantly warmer conditions; on the other hand, weather patterns bringing cold air masses were underrepresented in 2024. All in all, this makes it by far the warmest year on record for Austria. New records for the annual average temperature were reached at almost all stations in the country. For the area as a whole (HISTALP lowlands), this results in a deviation from the 1991–2020 climate average of +1.8°C. It was also the warmest year in the summit regions, and the anomalies from the climate average there amount to +1.9°C.

The first of a total of three monthly records was already broken in February. With a deviation from the 1991–2020 average of +5.5°C, this month reached the highest point in Austria's observational history to date. So far, no other month has shown such a high anomaly compared to the climatic average (so far, April 1800 dev. +5.0 °C). This was followed by the warmest March on record (dev. +3.4 °C), the third warmest July (dev. +2.1 °C) and the warmest August (dev. +3.0 °C). This sequence of extremely warm months resulted in the second-warmest winter (Dec extreme air temperature values in 2023 to Feb 2024), as well as the warmest spring and warmest summer. The first half of April was also extremely warm, which meant that new April temperature highs were recorded at around 100 GeoSphere Austria weather stations. The situation was similar at the beginning of September. Before a cold air mass caused a marked drop in temperature in the second third of the month, new monthly records for maximum daily temperatures were set at around 30 weather stations.

During the long midsummer period from mid-June to early September, there were no significant incursions of cold air that could have lowered the temperature level in a sustained manner and for a prolonged period. As a result, the 30 °C mark was exceeded very frequently, and some weather stations, especially in the eastern parts of the country, recorded new records for hot days. In the non-alpine regions of Austria, there were two to three heatwaves that lasted for an exceptionally long time, on average one to three weeks, and in some places up to nine weeks (Wiener Neustadt). After the sharp drop in temperatures in mid-September, there were only isolated instances of extremely high temperatures, such as at the beginning of November. However, above-average warm conditions continued to prevail, and only September in the highlands and November in the lowlands produced negative monthly results. The highest temperature deviations, of 2.2 to 2.4 °C, occurred in large parts of Lower Austria, as well as in North Burgenland and the Innviertel region. In most parts of the country, the anomalies were between +1.7 and +2.2 °C. In Vorarlberg, the Tyrolean Oberland, East Tyrol, Pinzgau, Pongau and large parts of Carinthia, the deviations from the 1991–2020 climate average reached +1.1 to 1.7 °C.

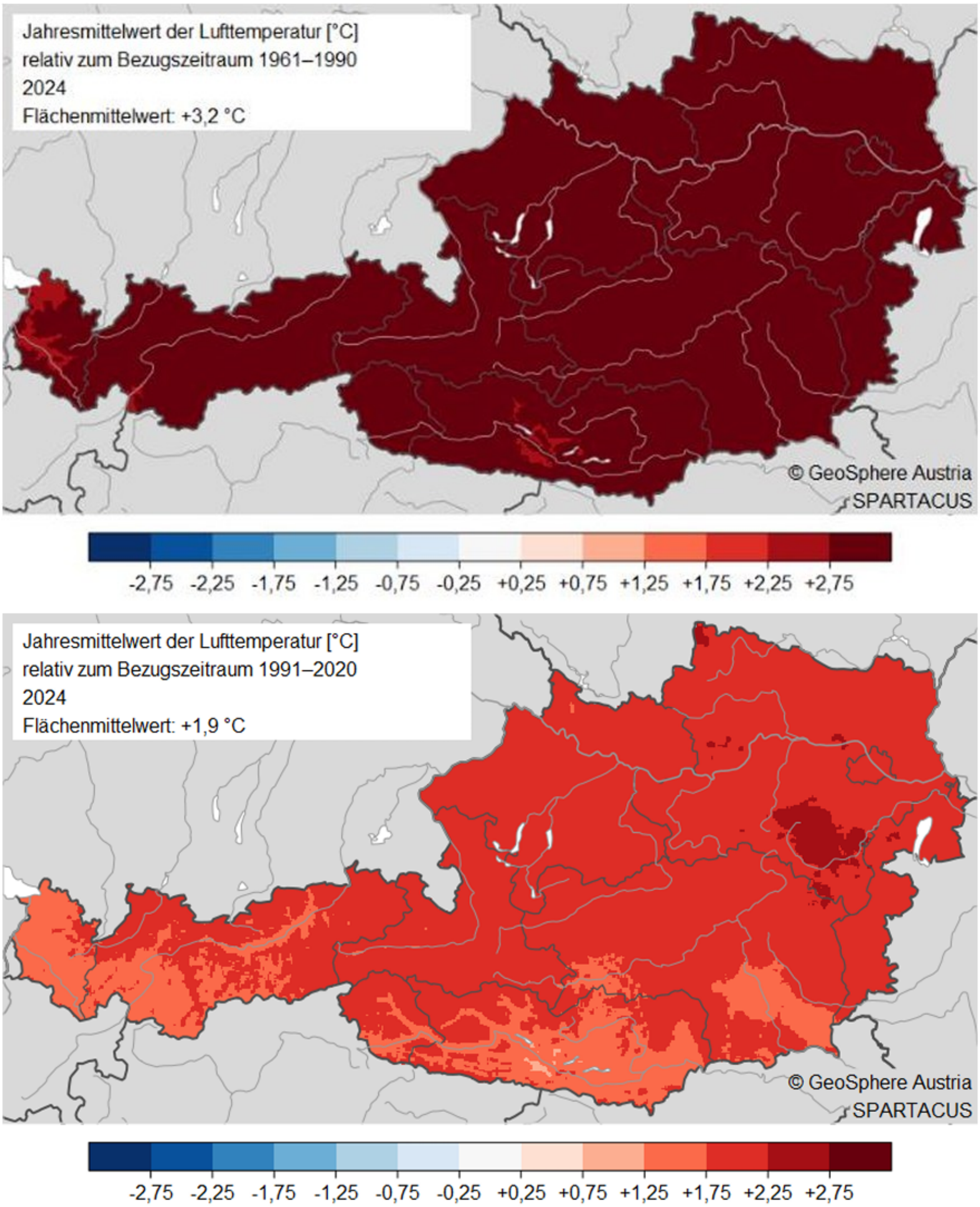


Figure 1: Temperature in Austria in 2024. Picture below compared to the average 1991-2020, picture above compared to the average 1961-1990. Source: GeoSphere Austria

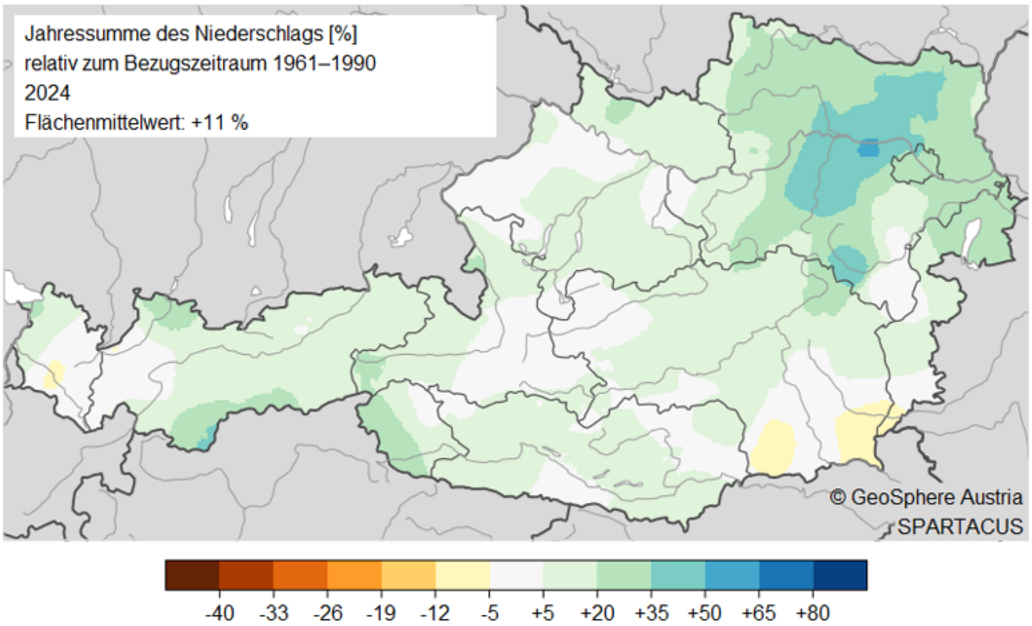
Precipitation

Up until mid-June, the increase in precipitation in 2024 was mostly average across Austria, or slightly below average, as in the northwest of the country, and in some places slightly above average in the south and west. In the summer, long dry periods prevailed in the northern, eastern, and south-eastern parts of the country, interrupted by heavy rainfall events. This was also evident in the west and south of the country but was not as pronounced there. The individual, relatively small-scale heavy rainfall events in summer were responsible for numerous cases of damage caused by hail, flooding, and landslides.

With the end of the midsummer heat in the first ten days of September, large-scale low-pressure systems – and thus polar cold air – reached Central Europe again for the first time in weeks. Alongside this change in the weather, a low-pressure system developed over the Gulf of Genoa, which subsequently dumped enormous amounts of precipitation over Austria. The result was severe flooding in places in Upper Austria, Lower Austria, and Vienna. After mid-October, autumnal high-pressure weather dominated, and there was generally very little precipitation. It was not until mid-December that precipitation activity picked up again.

With an area-averaged deviation of 7%, 2024 is one of the 30 wettest years in Austria's 167-year history of rainfall measurements. The biggest contribution to this came from the extremely rainy September. An example of the impact of the extreme rainfall in September on the overall balance: In St. Pölten, 409 mm of rain fell within five days in mid-September. This is a large proportion of the amount of precipitation that falls in St Pölten in an average year (723 mm). The amount of precipitation in May was also significantly higher than the average for the years 1991–2020. The two summer months of July and August were significantly too dry, with rainfall being a quarter to a third lower on average across the area. With a deficit of 71%, November was also particularly low in terms of rainfall. The remaining months brought typical amounts of precipitation, in line with statistical variation.

In the west and northwest of the country, as well as in parts of Upper Styria, in northern Burgenland and in large parts of Lower Austria, there was predominantly 5% to 25% more precipitation than average. Deviations from the climatic average of 25% to 40% were observed in parts of the Waldviertel and Weinviertel regions and from the Dunkelsteinerwald to the northern foothills of the Wienerwald. With up to 50% more precipitation than in an average year, the highest anomalies in the country were recorded in the Tulln Basin and the St Pölten area.



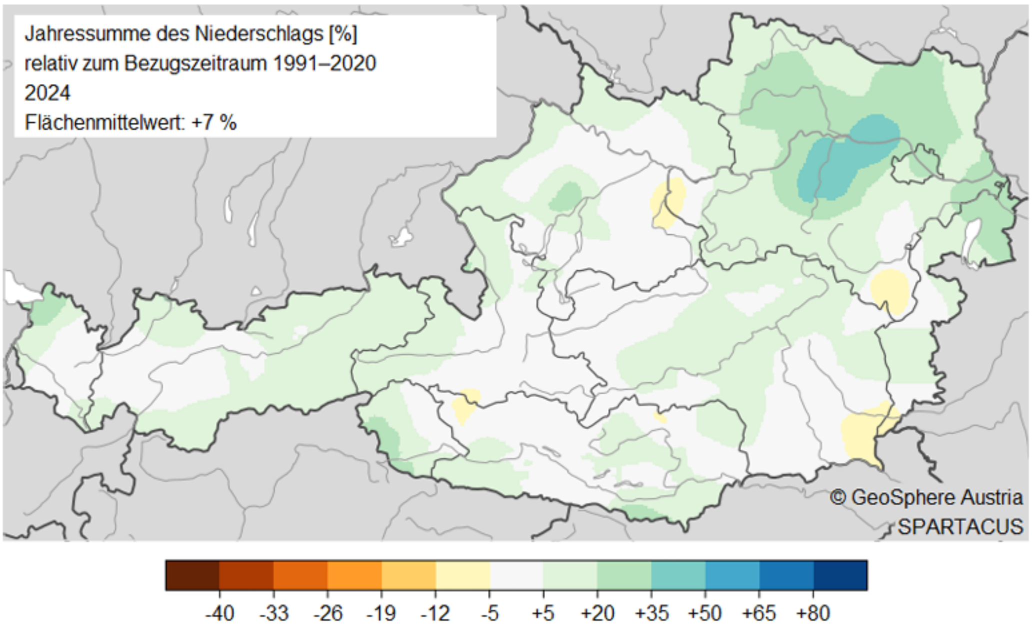


Figure 2: Precipitation in Austria in 2024: Deviation of precipitation from average. Picture below compared to the average 1991-2020, picture above compared to the average 1961-1990. Source: GeoSphere Austria

Sunshine

With an average anomaly of -2%, 2024 was about as low in sunshine as 2023. However, the deviations were not evenly distributed across the federal states. In the southwest, especially in East Tyrol and Upper Carinthia, as well as in North Tyrol along the main Alpine ridge, there was particularly little sunshine, with deficits of 10% to 20% compared to the climate average for 1991–2020. In Vorarlberg, in the rest of North Tyrol, in Lower Carinthia, in Lungau and in Styria along the Lower Tauern, as well as in Flachgau and parts of the Innviertel, the anomalies were between -5% and 10%. In most of the remaining parts of the country, the amount of sunshine was in line with the climate average (dev. +/-5 %). In the southern Vienna Basin and in northern Burgenland, the sun shone for 5% to 9% longer than the long-term average.

1.1.2 Meteorological characteristics of the Austrian Rhine region.

Source: Department of Water Management, Office of the Vorarlberg State Government, Bregenz

The annual precipitation total in 2024 was above average in the Austrian part of the Rhine catchment area, reaching **108%** of the long-term average. The monthly precipitation totals in May, June and September were quite clearly above the average for each month. The months of July, August and November recorded below-average rainfall, while the other months had roughly average rainfall totals (Figure 3).

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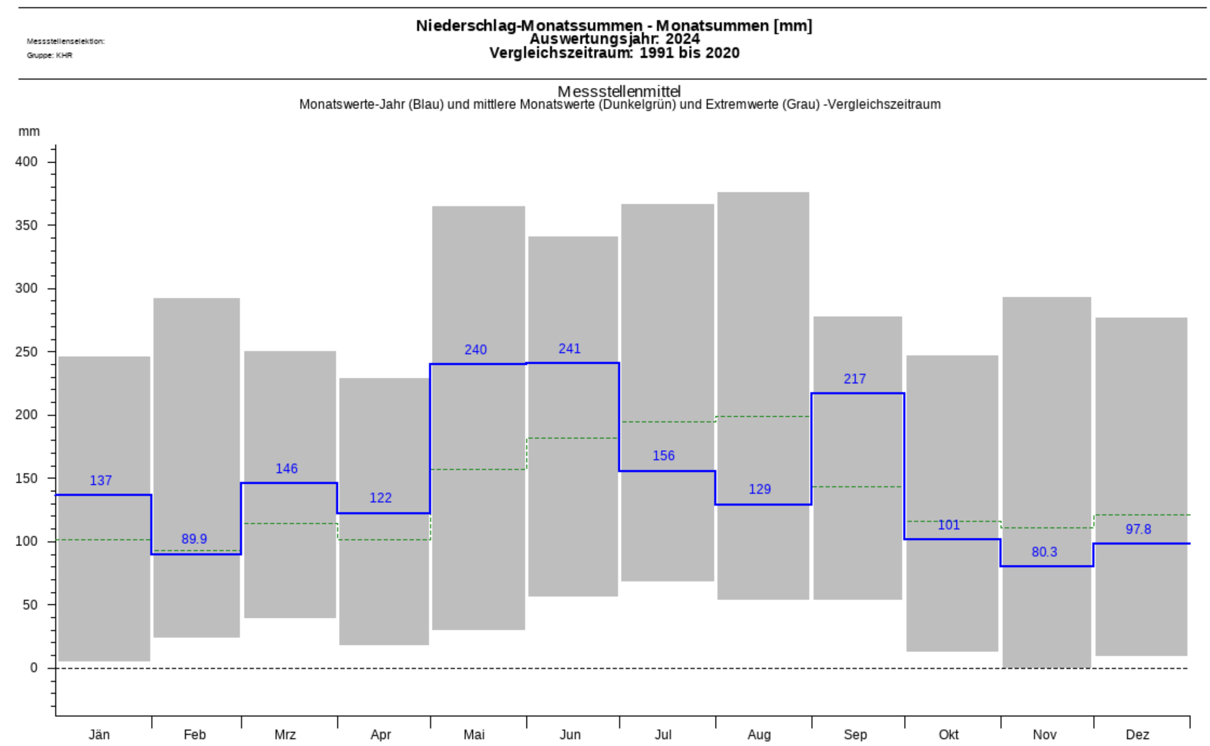

Figure 3: Total monthly precipitation in 2024 (blue values) compared with long-term monthly averages (1991–2020) at the Bregenz Altreuteweg measuring station.

1.1.3 Switzerland

Source: Federal Office of Meteorology and Climatology(MeteoSwiss)

Throughout the entire 2023/24 winter, total precipitation levels generally reached 130 to 160% of the 1991–2020 norm. Locally, it was one of the ten wettest winters since records began. In the mountains on the southern side of the Alps, there were considerable amounts of fresh snow, especially at the end of February and the beginning of March.

In most parts of Switzerland, above-average levels of precipitation fell in spring 2024. The very wet conditions on the southern side of the Alps and in the adjacent areas were striking. The cause of the spring dampness was widespread precipitation in March and May.
The nationwide average summer temperature was 1.6 °C above the 1991–2020 norm. It was the sixth warmest summer since records began in 1864. The three summer months together brought widespread below-average precipitation, ranging from 70% to 90% of the norm.

Severe storms in summer
The rainy month of May, with heavy precipitation at the end of the month and further heavy precipitation in the first few days of June, led to a tense flood situation with flooding in eastern Switzerland, from Lake Lucerne to Lake Constance and along the Rhine.

From 20 to 21 June, warm, humid air transported from the south over the Alps brought heavy precipitation to the southern Valais valleys and the southern side of the Alps. Together with snowmelt from the previous midsummer period, this resulted in large discharge volumes. In the regions of Zermatt (Valais) and Misox (southern side of the Alps), there was extensive damage caused by streams that were in flood and the masses of rubble they carried with them.

On 29 June, moist and unstable air was brought into the Alpine region from the south. Parts of Upper Valais and Ticino were hit by severe thunderstorms, which brought enormous amounts of precipitation in a short space of time. The heavy precipitation caused streams and rivers to swell massively in a short space of time and to burst their banks.

From 6 to 7 July, there was heavy precipitation from southern Ticino, through Bergell, to the Upper Engadine. Water from rising streams and the debris they carried along caused localised damage.

On 12 August, severe thunderstorms with heavy rainfall in a short period of time broke out locally over the Bernese Oberland. Water and sediment masses caused extensive damage to houses, roads, and railway infrastructure in Brienz.

After a September that was slightly cooler than normal, October and November were exceptionally mild, especially at higher altitudes. The three autumn months together brought above-average total precipitation in many areas.

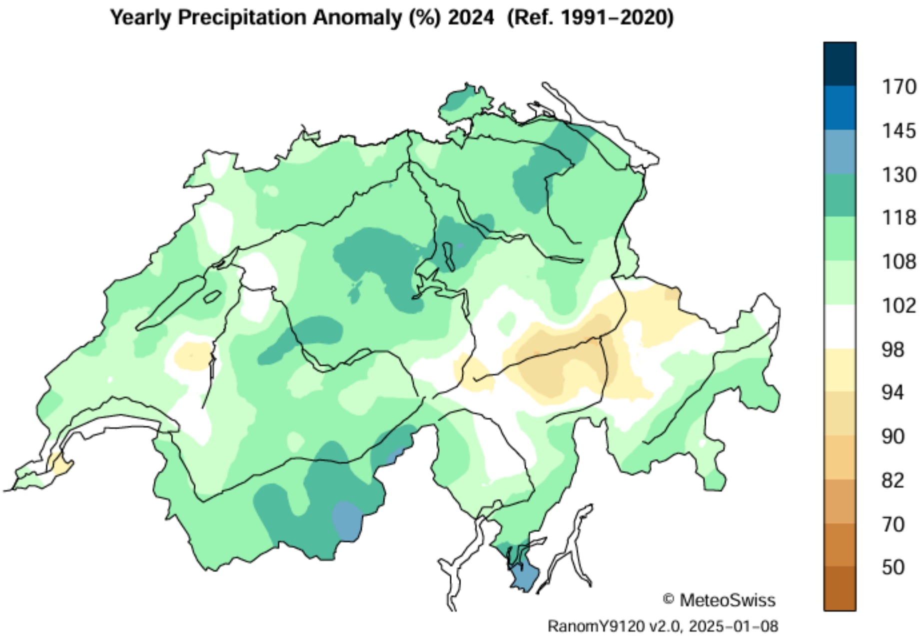

Figure 4: Annual precipitation total Switzerland 2024 as a percentage of the standard (1981-2010). In 2024, annual precipitation in most areas reached 90% to 115% of the 1991–2020 norm.
Source: MeteoSwiss.

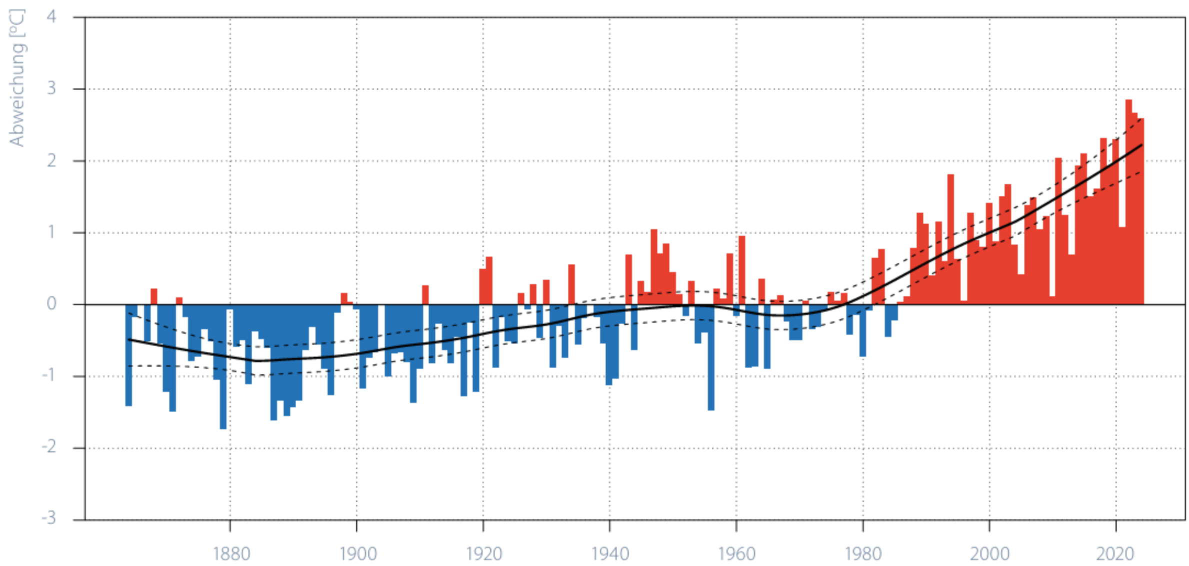

Figure 5: Long-term trend of the annual temperature averaged across the whole of Switzerland. Annual deviation of the temperature in °C from the standard 1961–1990 is shown (red = positive deviations, blue = negative deviations). The black curve shows the 30-year smoothed average (local linear regression LOESS). The dashed lines indicate the uncertainty range of this average (95%- confidence interval). Source: MeteoSwiss.

Table 1: 2024 annual values at selected MeteoSwiss measuring stations compared to the 1991-2020 standard. Data source: MeteoSwiss.

Station	Höhe	Temperatur [°C]			Sonnenscheindauer [h]			Niederschlag [mm]		
	m ü. M.	Mittel	Referenz[1]	Abw.[2]	Summe	Referenz[1]	%[3]	Summe	Referenz[1]	%[3]
Bern	553	10.6	9.3	1.3	1542	1797	86	1022	1022	100
Zürich	556	11.0	9.8	1.2	1508	1694	89	1281	1108	116
Genf	420	12.1	11.0	1.1	1693	1887	90	908	946	96
Basel	316	12.2	11.0	1.2	1539	1687	91	831	842	99
Engelberg	1036	8.4	6.8	1.6	1263	1380	92	1762	1568	112
Sion	482	11.7	10.7	1.0	1965	2158	90	635	583	109
Lugano	273	13.9	13.0	0.9	2019	2120	95	1786	1567	114
Samedan	1709	3.8	2.4	1.5	1589	1767	90	782	710	110

[1] Langjähriger Durchschnitt 1991–2020
[2] Abweichung der Temperatur zur Referenzperiode 1991–2020
[3] Prozent im Verhältnis zur Referenzperiode 1991–2020 (Referenz = 100 %)

1.1.4 Germany

Source: Federal Institute of Hydrology – BfG

The year 2023, which can be classified as a "normal year" with 918 mm of annual precipitation in the Rhine region, was followed by an above-average wet year in the hydrological year 2024 (November 2023 to October 2024). This is evident in the two catchment areas of the Rhine area considered here (Basel level to Mainz level, AEo 62,309 km² and Mainz level to Lobith level, AEo 61,690 km²). Averaged over both sub-catchment areas, 1,189 mm of precipitation was recorded in 2024, which is almost 130% of the long-term average precipitation for the time series from 1981 to 2010 (see Figure 6).

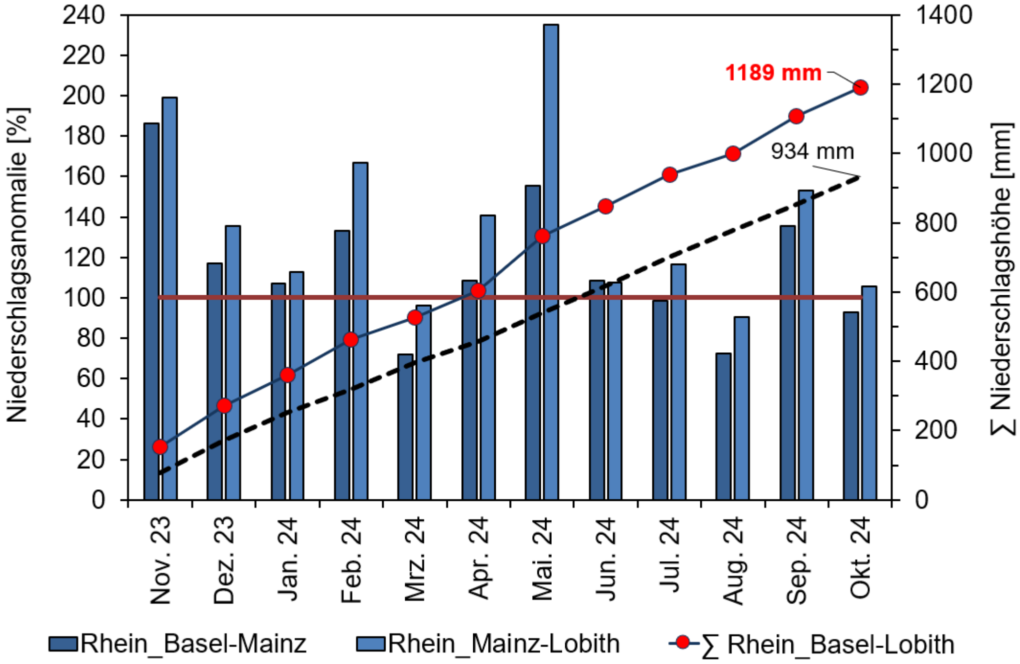

Figure 6: Monthly relative anomalies (blue bars) of the areal precipitation levels for the 2024 hydrological year in the Rhine region for the Upper Rhine sub-basins (Basel to Mainz, including the Main, 62,309 km²) and the Middle and Lower Rhine (Mainz to Lobith, 61,690 km²) based on the 1981–2010 reference series (purple horizontal line). The summed monthly regional precipitation levels for the Rhine region from Basel to Lobith (∑) for the hydrological year 2024 (black line with red dots) are also plotted, compared with the total line for the time series from 1981 to 2010 (dashed line) (data source: DWD and meteorological services of neighbouring countries, preliminary data, analysis: Federal Institute of Hydrology).

The distribution of monthly precipitation throughout the year naturally varied. The months of November 2023, February 2024, May 2024, and September 2024 were very wet, with relative anomalies of 193%, 151%, 194% and 145% for the Rhine region between Basel and Lobith. The months of December 2023, January 2024, April 2024, June 2024, and July 2024 were moderately wet, with relative deviations between 107% and 127%. Only the two months of March 2024 and August 2024 were drier than the climatological average (rel. deviations of 85% and 82%). The regional precipitation recorded for October 2024 was in line with the long-term average for this month. In almost all months, the northern sub-area of the Rhine (Middle and Lower Rhine with the Moselle) was wetter than the Upper Rhine and Main area (see Figure 1). The differences were particularly striking due to the special weather conditions in May 2024 (see below).

At 11.2 °C, the annual average temperature in the area between Basel and Lobith was +1.9 degrees (previous year: 1.7 degrees) above the long-term average from 1981 to 2010. Compared to the warm previous years, the annual average temperature was thus once again comparably high. All monthly mean air temperatures for the hydrological year 2024 were above the long-term average for the reference period. February 2024 stands out in particular, with a deviation of 5.5 degrees. However, the air temperatures in December 2023, March, August, and October 2024 were also significantly above the reference value for 1981 to 2010, at +2.9 degrees, +2.8 degrees, +2.4 degrees and +1.7 degrees (see Figure 7).

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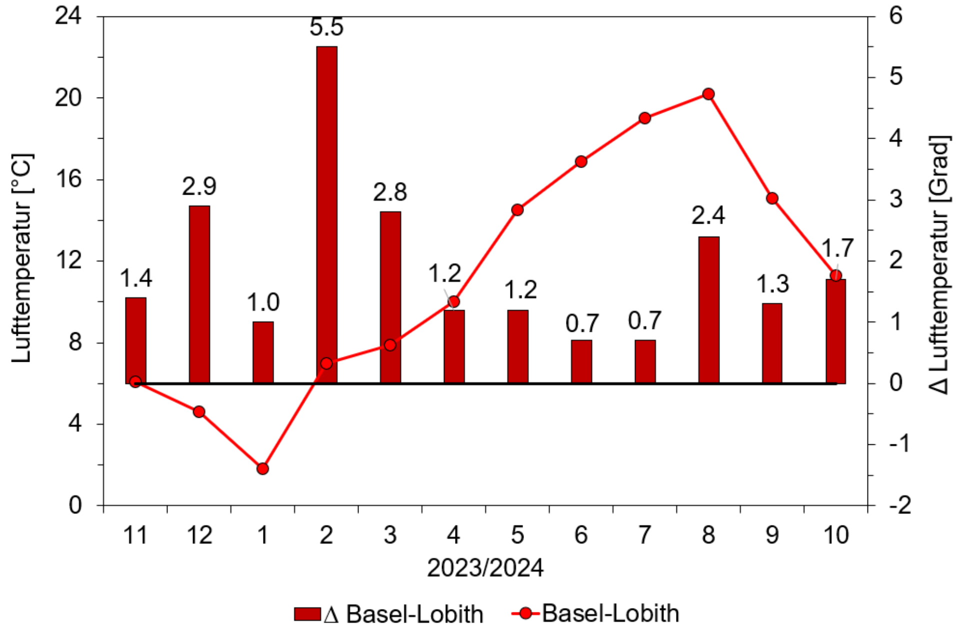

Figure 7: Monthly average and monthly anomalies of the air temperature for the partial catchment area of the Rhine from Basel to Lobith for the hydrological year 2024. The anomalies of the air temperature (Δ, columns, referring to right ordinate) refer to the time series 1981 to 2010. (Data source: DWD and weather services of the neighbouring countries, evaluation: Federal Institute for Hydrology).

Focusing on the German part of the Rhine region, the weather conditions of the individual months of the 2024 hydrological year can be characterised as follows (cf. German Weather Service (2025)):

In November 2023, low-pressure systems swept across Germany in quick succession, bringing plenty of rain and storms. Precipitation was particularly heavy in the second ten-day period of the month. Some precipitation measurement stations in the Black Forest recorded monthly totals of more than 500 mm. While mild weather prevailed for most of the month, there was a temporary onset of winter towards the end of the month. Snow also fell in the lowlands, and in some mountainous regions there were even severe disruptions to rail and road traffic.

At the beginning of December 2023, winter temperatures still prevailed. After that, low-pressure systems with storms and mild temperatures dominated the weather. Towards the middle of the month, partly sunny high-pressure weather temporarily prevailed. Persistent rainfall, thawing, and saturated soils caused rivers and streams to burst their banks in the third ten-day period. Shortly before Christmas, an extratropical cyclone with its centre over northern to north-eastern Europe caused gale-force and hurricane-force gusts, very mild temperatures, and heavy, prolonged rain, especially in the north and north-west.

The wet weather also continued into early January 2024. From the first weekend of January, dry, cold weather set in, before a pronounced air mass boundary brought widespread freezing rain and snowfall to the central and southern regions on the 17th and 18th. In the third ten-day period, troughs of low pressure, accompanied by storms and mild temperatures, moved across Germany towards the east in rapid succession. At the end of the month, a strong area of high pressure brought a lot of sunshine.

In February 2024, low-pressure systems and their fronts repeatedly caused precipitation, which brought high monthly totals, especially to the west and the low mountain ranges. Precipitation mainly fell as rain; snow at low altitudes only occurred sporadically and for short periods. It was often stormy and sometimes very mild for the time of year. High-pressure phases only lasted briefly. There were very few days of frost. It remained frost-free on the North Sea coast and locally in the west. In the middle of the month, low-pressure system "Rixa" brought subtropical warm air with temperatures of up to almost 20 °C as far as the Baltic Sea coast. February 2024 was the warmest February in Germany since records began.

On the first weekend of March, a southerly flow brought very mild weather. Subsequently, the sun often prevailed with an easterly flow. From the second ten-day period onwards, with winds that were mostly westerly and later more southerly, there was a change from very mild, sometimes sunny periods to the passage of cold fronts with rain showers, brief thunderstorms, heavy rain, and gale-force gusts. March 2024 was the warmest March ever recorded in Germany. There was no frost in places on the coasts, in the west, and along the Rhine and Neckar. On the 30th, warm air with maximum temperatures of up to 25 °C, enriched with Saharan dust, reached Germany.

The influx of warm air masses from the south continued into early April 2024. In the middle of the month, the flow turned towards northerly directions and brought sea air of polar origin to Germany. Widespread frost occurred on the nights of 22–25 April. As vegetation was already well advanced, there was considerable frost damage. In the middle of the month, it even snowed briefly at low altitudes. The snow cover increased again at higher altitudes. At the end of the month, the current turned south again, and the temperature rose once more.

Daily precipitation levels and daily mean temperatures, as well as the snow water equivalents calculated using the LARSIM-ME water balance model, are shown for the hydrological winter half-year in Figure 8. Two phases of snowpack formation are clearly discernible: the end of November 2023 and mid-January 2024. This was followed by corresponding snowmelt periods due to the predominantly mild weather.

The hydrological summer half-year of 2024 began in May with a stable blocking weather pattern, with low-pressure areas hardly being able to shift eastwards due to persistent high-pressure areas in eastern to north-eastern Europe. There was repeated precipitation, especially in the west and south of Germany, often accompanied by thunderstorms and heavy rain. It was under these conditions that the "Katinka" low-pressure system also developed in mid-May, causing extreme levels of precipitation, particularly in Saarland and Rhineland-Palatinate, and leading to the Whitsun floods on the Saar. In some areas of the Middle Rhine, monthly precipitation totals of more than three times the long-term average were recorded.

The period of wet weather that had been ongoing since the end of May 2024 continued into the first few days of June, exacerbating the flooding situation in southern Germany. Low-pressure systems also continued to dominate afterwards, bringing localised heavy rain, hail, gale-force gusts, and even isolated tornadoes. In the third ten-day period of the month, there was a brief period of high-pressure influence with sunnier and drier weather. However, the wet, humid weather returned at the end of the month.

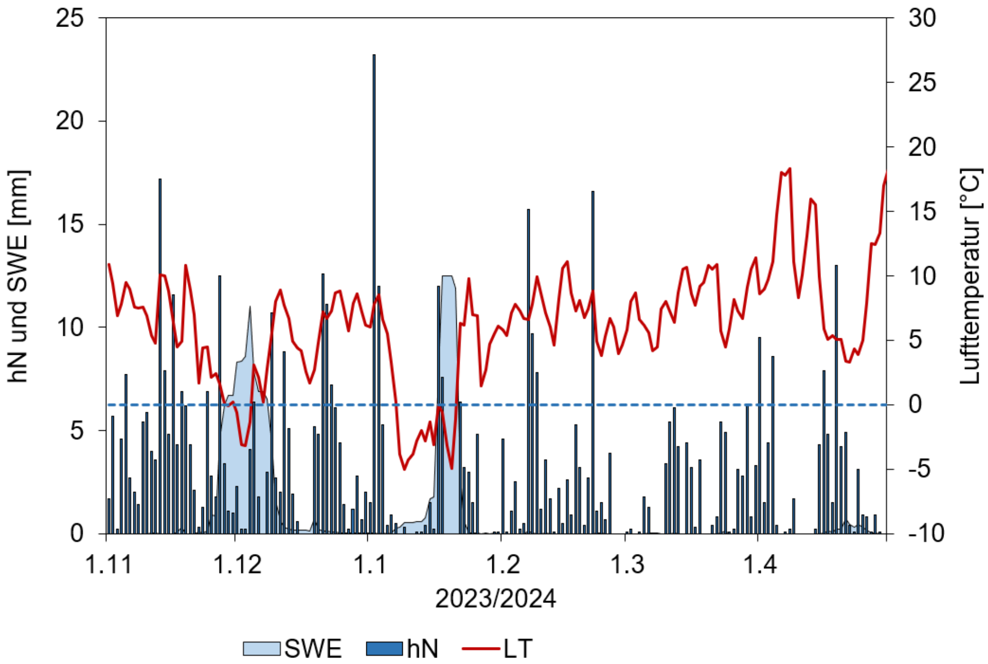

Figure 8: Daily values of precipitation (hN), snow water equivalent (SWE), and air temperature (AT) for the areal mean of the Rhine sub-catchment from Basel to Lobith for the hydrological winter half-year 2024 (1/11/2023 to 30/04/2024). The dashed red line represents the zero-degree line (data source: DWD and weather services of the neighbouring countries, evaluation: Federal Institute for Hydrology)

In July 2024, the changeable weather of the previous month continued. It remained a pattern of alternating high-pressure systems, bringing sunny and dry summer weather, and low-pressure systems, whose trailing edges passed over parts of Germany, accompanied by thunderstorms and heavy rain. The month was, on average, wet for the region. However, the dominance of convective precipitation led to major differences in terms of space and time. In humid and warm air masses, temperatures did not fall below 20 °C on some nights in some areas.

Prolonged dry high-pressure periods with plenty of sunshine alternated with low-pressure areas in August 2024, which brought humid, hot air to Germany and, in some areas, caused thunderstorms with hail, storms and heavy rain. However, widespread precipitation generally did not occur. Overall, the month was slightly to moderately drier than the long-term average in the Rhine region and significantly too warm throughout Germany. There were an above-average number of summer days across the board, and the temperature exceeded 35 °C on several days. Several stations recorded tropical nights, during which the temperature did not fall below 20 °C.

After a start that felt like the height of summer, there was an abrupt change in the weather in the second ten days of September 2024, with significantly cooler temperatures. The Mediterranean low-pressure system "Boris" brought extreme levels of rainfall to eastern Central Europe, leading to severe flooding in Austria, the Czech Republic and Poland. In Germany, Eastern Saxony, the Bavarian Forest, and Upper Bavaria were directly affected by heavy, prolonged rainfall. The first significant snowfall occurred in the Alps. After a brief return of summer in the third week of September, cooler and unsettled weather set in at the end of the month. Although the Rhine region was not directly affected by the aforementioned storm depression in the middle of the month, the month was also wetter than average here.

The last month of the 2024 hydrological year, October, was less turbulent overall. The first week of October was quite chilly. At the end of the first ten days, mild air with a lot of precipitation reached Germany. A few days later, a cold front, along with a drop in temperature, brought showers and gale-force gusts. In the second half of October, high pressure generally prevailed, interrupted only by isolated frontal passages with little precipitation. During this period, sunlight was insufficient to dispel the blanket of fog in many places.

1.1.5 The Netherlands

Source: Royal Netherlands Meteorological Institute (KNMI)

Temperature

The year 2024 was exceptionally warm in the Netherlands. With an average temperature of 11.8 °C at De Bilt, 2024, together with 2023, set the record as the warmest year since measurements began in 1901. The winter and spring months, in particular, were unusually mild; both February and spring 2024 were the warmest ever recorded for their respective seasons. The number of frost days was the lowest since records began, and for the second year in a row, no ice days were recorded. The high annual average temperature was mainly due to exceptionally mild nights and above-average temperatures for almost the entire year.

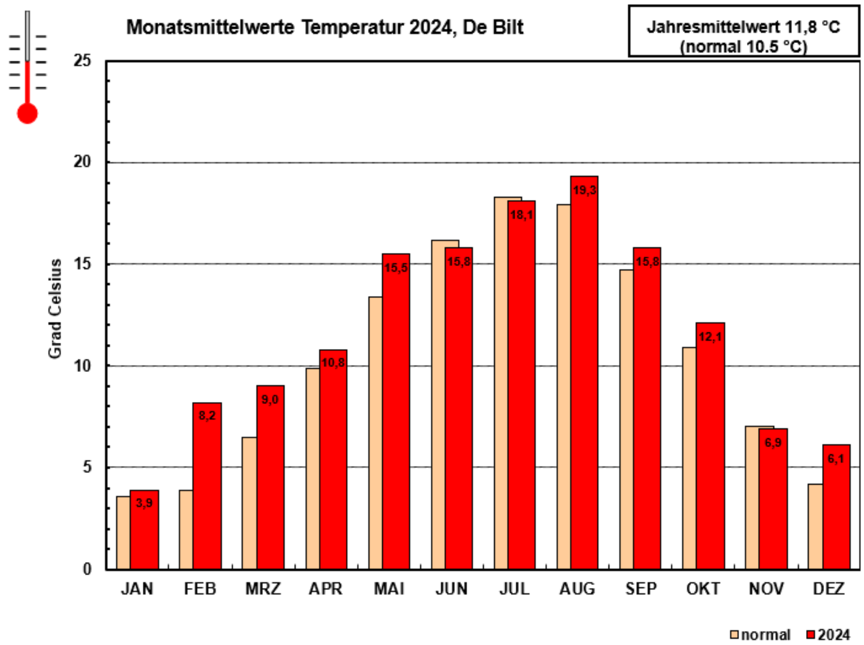

Figure 9: Monthly temperature averages at the station De Bilt 2024 compared to the long-term (1991-2020) average (source: KNMI)

Precipitation

The year 2024 was once again exceptionally rainy in the Netherlands. With a nationwide annual precipitation total of around 1,060 mm, significantly more precipitation fell than the long-term average of around 795 mm. The months of February, May, and September, in particular, were very wet, while August was comparatively dry. Following the record rainfall year of 2023, 2024 was also one of the wettest years since systematic measurements began. The high levels of precipitation led to increased discharge in many rivers and to persistently high soil moisture in large parts of the country. The spatial distribution of precipitation largely corresponded to the long-term pattern, with the highest totals once again being observed in the west and south of the Netherlands.

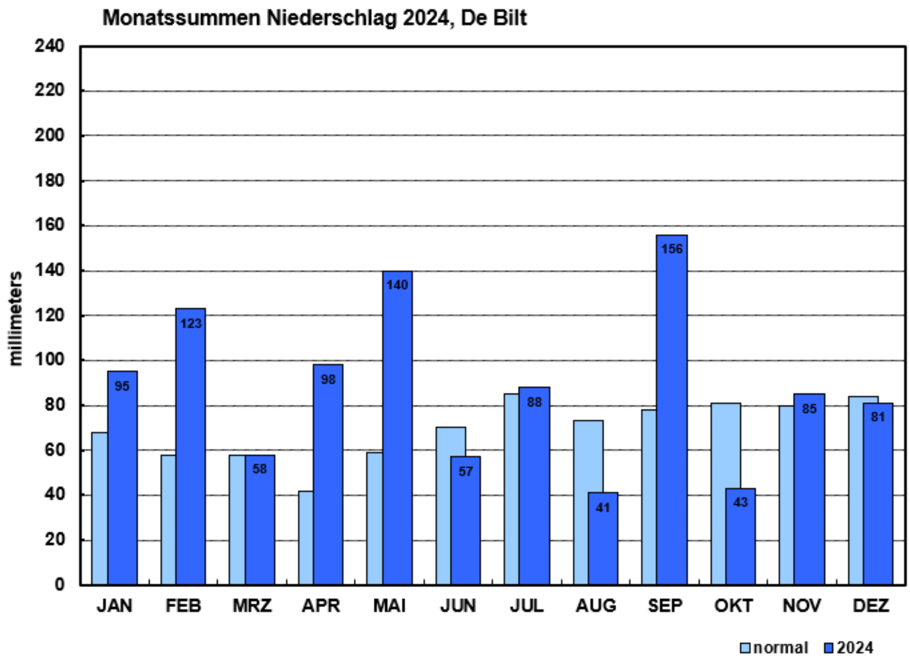

Figure 10: Monthly totals of precipitation at De Bilt station for 2024 compared to the long-term (1991-2020) average (source: KNMI)

Sunshine

Despite the exceptionally high levels of precipitation, 2024 was a year with almost normal sunshine hours in the Netherlands overall. On average across the country, the number of hours of sunshine was roughly in line with the climatological average. While spring was rather lacking in sunshine, with all three spring months recording fewer hours of sunshine than usual, the shortfalls were partially offset in other seasons. January, in particular, was sunnier than usual, while February was exceptionally overcast. Overall, 2024 was therefore significantly wetter and warmer than usual, but the duration of sunshine did not show any unusual deviations from the long-term average.

1.2 Snow and glaciers

1.2.1 Snow

Source: WSL Institute for Snow and Avalanche Research SLF

Winter started with a lot of snow in the north. From mid-November until Christmas 2023, snow fell repeatedly to the north of the main Alpine ridge; at high-altitude stations, snow depths that were well above average were widespread. A relatively thick snow cover formed in the north. There was less snow at mid-altitude locations due to the sometimes high snow line. From Christmas until the end of January, the situation changed; there was less fresh snow. From mid-February to early April, repeated and pronounced southerly foehn situations brought a lot of precipitation to the southern slopes of the Alps and, in some cases, also to the main ridge of the Alps.

In spring 2024, too, it never remained sunny and dry for long, but there was repeated precipitation, in the form of snow at higher altitudes. Two distinctive, very warm periods in the first half of April rapidly accelerated moisture saturation of the snowpack. For example, by mid-April, the northern slopes were already saturated with moisture up to around 2,500 m above sea level, and the eastern, southern, and western slopes were even saturated up to the high mountains. From mid-April onwards, winter returned to the north with a marked drop in temperature and a lot of snow. Up to two metres of fresh snow were recorded in the north by the end of April.

Fresh snow and snow depths in a long-term comparison

The winter of 2023/24 was characterised by stark contrasts on both sides of the Alps. Below 1,400 m above sea level, snow depths were clearly below average, and above 2,200 m above sea level, they were clearly above average. This was due to large amounts of precipitation, but also to temperatures that were well above average throughout the entire winter half of the year. Therefore, only high altitudes were able to benefit from the frequent snowfall and record an average duration of snow cover. It was only in the high mountains that the snowmelt took place a few weeks later than usual.

The summer of 2024 was the sixth warmest summer since records began. The high temperatures – probably also partly due to the Saharan dust – led to rapid snowmelt in summer, even in the high mountains. The only significant snowfall was in September, and this snow largely disappeared again afterwards.

1.2.2 Glaciers

Source: Department of Geosciences at the University of Freiburg and the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) at ETH Zurich

After the extreme years of 2022 and 2023, there is no relief in sight for Swiss glaciers: despite exceptionally large amounts of snow in winter, sometimes record-high temperatures in July and August, combined with Saharan dust, led to a loss of 2.5 percent of glacier volume.

The glacier year 2024 is characterised by stark contrasts: until June, conditions for Swiss glaciers were exceptionally favourable, thanks to 30 percent more winter snow than average and a rainy early summer. However, the Saharan dust that stained the snow surface accelerated melting, and August saw the greatest loss of ice since records began. Overall, glaciers also melted significantly in 2024, as data from the Swiss Glacier Monitoring Network (GLAMOS) shows.

The retreat of glacier tongues and their disintegration are continuing unabated as a result of climate change. In the previous years of 2022 and 2023, a total of 10 percent of Switzerland's glacier volume disappeared – more than ever before. This year's loss of around 2.5 percent is also above the average for the last decade. Although the large amounts of snow during winter were able to slow down the loss of ice, they could not stop it. For example, in mid-May, six metres of snow were still measured on the Claridenfirn (Glarus), and this had completely disappeared by September. Glaciers below 3000 m above sea level, on the other hand, melted completely and showed losses of up to two metres in ice thickness (e.g., Glacier du Giétro (VS), Glacier de la Plaine Morte (BE), Silvretta Glacier (GR)). For glaciers with southern influence, the loss was somewhat less pronounced thanks to very heavy snowfall in winter (e.g., Ghiacciaio del Basòdino (TI)).

1.3 Hydrological Situation in the Rhine Basin 2024

1.3.1 Water levels of the major lakes in the Rhine basin

1.3.1.1 Austria

Source: Department of Water Management, Office of the Vorarlberg State Government, Bregenz

With record levels in December of the previous year, the water levels of Lake Constance from the beginning of 2024 to the beginning of May were quite clearly above the long-term average values for the series 1864–2023 for the respective calendar day. The flooding at the end of May/beginning of June caused the water level to rise by more than 100 cm. Statistically, the Lake Constance water level corresponded to a 10-year flood event. It was not until mid-July that the water level fell continuously below the long-term average values until the beginning of September. With above-average rainfall in September, the water level rose again by mid-October. The water levels then fell until the end of December.
At 380 cm, the annual average water level in Bregenz was 35 cm higher than the long-term annual average (345 cm).

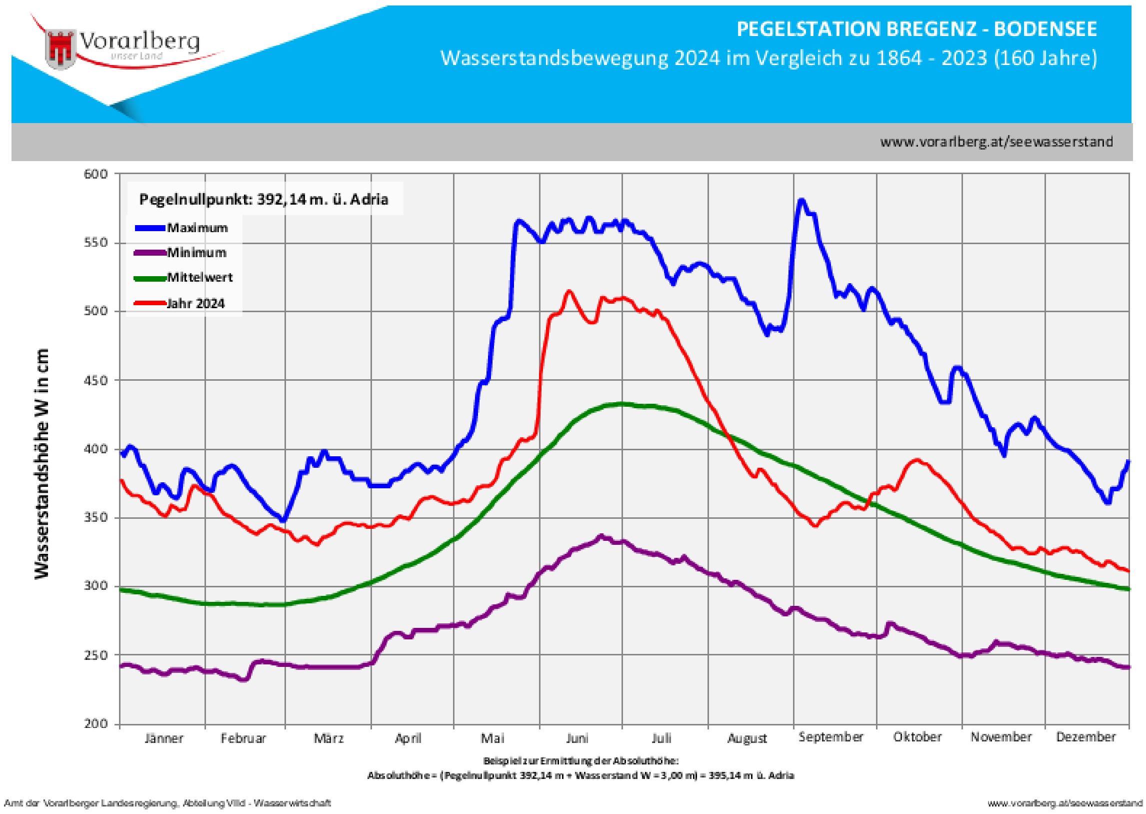

Figure 11: Hydrograph of the water level of Lake Constance at the Bregenz gauge in 2024 (red curve) compared to long-term minima, maxima, and mean values (Series 1864 – 2023)

1.3.1.2 Switzerland

Source: Swiss Federal Office of the Environment (BAFU)

About half of the large lakes had balanced annual average levels, while the others were significantly above the long-term average. Lake Thun, with -3 cm, was an exception due to a planned, extraordinary lowering of the lake at the beginning of the year. The greatest deviations from the 1991–2020 norm can be found at Lake Maggiore and Lake Constance. Two smaller lakes, Lake Baldegg and Lake Sempach, recorded a new June high.

The water level in Lake Constance was already more than half a metre above the usual level at the beginning of the year. However, the biggest differences occurred during the floods in June and July: during this period, the level was at hazard level 2 or higher for almost 60 days, 26 of which were at hazard level 4. The absolute maximum values from 1999 are still around 60 cm higher. Of the large lakes, only Lake Constance (Obersee and Untersee) reached level 4 in summer 2024.

From February onwards, the water level of Lake Neuchâtel followed the median curve of the standard period. Accordingly, the difference in the annual mean value was minimal. The large, regulated lakes on the northern side of the Alps could also be controlled in accordance with regulations during the summer floods.

In all months of the year, the mean values at Lake Maggiore were higher than in the normal period. Hazard level 2 was reached for a few days at the beginning of April and in mid-May. Lake Lugano rose to hazard level 3 within a few days. In 2024, there were significant deviations from the average water level at Lake Geneva. The June floods on the Rhône caused the lake to rise to hazard level 2.

1.3.2 Water levels and discharges of rivers

1.3.2.1 Austria

Source: Department of Water Management, Office of the Vorarlberg State Government, Bregenz

In 2024, the discharge of the Alpine Rhine was 26% higher **than** the long-term average. The two largest tributaries from Austria, the Bregenzerach and the Dornbirnerach, also had a below-average annual load.
In 2024, flooding events that occur approximately every three years were recorded on the Alpenrhein, the Bregenzerach and the Dornbirnerach.
On 31st May/1st June, a flood event of a magnitude that occurs far less frequently than once every 100 years occurred on the Leiblach.

The average annual discharge compared to the long-term average was:

- on the Bregenzerach 119% (mean discharge in 2024 = 55.3 m^3/s, long-term mean discharge = 46.6 m^3/s, annual series 1951–2023);
- at the Dornbirnerach 109% (mean discharge in 2024 = 7.70 m^3/s, long-term mean discharge = 7.06 m^3/s, annual series 1984–2023);
- on the Leiblach 127% (mean discharge 2024 = 4.06 m^3/s, long-term mean discharge = 3.19 m^3/s, annual series 1976–2023);
- on the Alpine Rhine 126% (mean discharge in 2024 = 292 m^3/s, long-term mean discharge = 231 m^3/s, annual series 1951–2023).

1.3.2.2 Switzerland

Source: Swiss Federal Office of the Environment (BAFU)

In 2024, the annual mean discharge in the larger catchment areas was mostly above the values for the standard period 1990–2020. The discharge levels of the Doubs at Ocourt and the Birs at Münchenstein were close to the long-term average. The Aare, Reuss and Limmat, which converge to form the Aare in Brugg, and the Maggia near Locarno provided more discharge – 110% to 120% of the norm. Significantly above-average discharges (over 120%) were observed in Eastern Switzerland on the Thur near Andelfingen and on the Rhine near Diepoldsau, as well as on the Ticino near Bellinzona. At just under 140%, the Rhône at Porte du Scex and the Inn at Martina deviated even more from the norm. Several FOEN monitoring stations recorded new highest annual averages in their monitoring period, particularly on the Rhone from Reckingen im Goms to its mouth at Lake Geneva. In addition to the major floods in June, the pronounced melting of snow and glaciers contributed significantly to these large discharge volumes. Exceptionally high annual averages were also recorded on the Aare up to Brienzwiler and in Bern. They are in the range of the values from 1999 – the year of the "avalanche winter" and extreme flooding on Ascension Day and Whitsun. In 2024, however, there were no major, individual peak discharge levels on the Aare; instead, there were longer periods with above-average values from the end of May to the end of October. Other catchment areas with high annual mean values were the Engelberger Aa near Buochs and the Kleine Emme near Werthenstein in Central Switzerland, as well as the Sitter near Appenzell, the Seez near Mels and the Julia near Tiefencastel in Eastern Switzerland and Southeastern Switzerland.

The range of annual runoff in the larger catchment areas varies from 100% to around 140% (see above); in the medium-sized catchment areas, the range is significantly wider, at 70% to 180%. The larger a catchment area is, the less local extreme events are visible in the evaluations. This applies to both wet and dry conditions. The discharge at the measuring station is the sum of the discharges in the sub-catchment areas, so that below- and above-average values often balance each other out.

The factors that contributed to the described deviations of the annual averages from the norm included, among others, the rainy spring, especially on the southern side of the Alps; heavy rainfall at the end of May/beginning of June in northeastern Switzerland; several phases with widespread, heavy rainfall at the end of June, combined with pronounced snowmelt in Valais, Ticino and Grisons; heavy rain and thunderstorms in southern Ticino, in Bergell and in the Engadine at the beginning of July; heavy thunderstorms during the summer, e.g., on the eastern northern slope of the Alps at the end of July and in mid-August in the Brienz region, as well as above-average rainfall in the autumn months.

Five catchment areas are used to illustrate what happened in the reporting year. As at other monitoring stations in the Rhone Valley, the discharge rates of the Rhone at Porte du Scex were significantly higher than normal, not only in summer, due to the extreme flooding events. Spring and autumn were also wet, resulting in above-average levels in every month of the year. In addition to new annual mean highs, several monitoring stations in the Rhone Valley recorded new highs for the month of June and new absolute highs. At the Inn at Martina, where the annual surplus was even greater than at the Rhone, there were not only floods in June and July with return periods of between 10 and 30 years, but also months with discharges that were around the norm (March and August) or just below it (September and December). The large surpluses in the middle of the year dominated the overall result. The Thur at Andelfingen, with an annual discharge 20% higher than the expected value, showed both extremes: months with unusually high discharges, but also months with values well below average. In June, almost two and a half times as much water flowed through the Thur as on average for that month, and in August only slightly more than half. The peak of the flood at the beginning of June was not extreme, with a return period of two to five years, but five days with values well above 200 m^3/s resulted in a considerably high June average. The Doubs owes its average annual discharge to one third of normal monthly discharges, one third of above-average monthly discharge levels and one third of below-average monthly discharge levels. March and August only provided around half of the normal discharge. On the other hand, the wet and mild winter of 2023/24, the heavy rainfall at the end of May/beginning of June and the wet October resulted in above-average discharge levels in the Doubs. The Maggia near Locarno was also a particular example. No month saw a normal discharge (normal here means monthly average between 75% and 125%). The variability of the Maggia's discharges is so great that extreme values are not unusual. The high discharge rates from March (340%) to June were offset by low discharge levels in August, September (both only one third of the norm), November and December. On 30 June, a new record high was observed on the Maggia at Bignasco, with a return period of over 100 years. At the Maggia near Locarno, the 1,800 m^3/s measured there is expected to occur about once every 5 years, according to statistics. The sub-catchment area up to Bignasco covers about one third of the total catchment area of the Maggia up to Locarno.

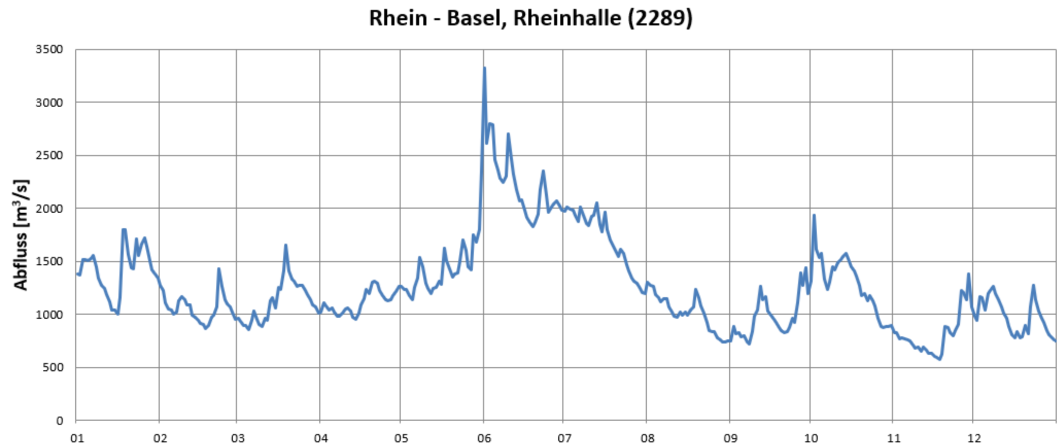

Figure 12: Discharge hydrograph at the Rhine - Basel, Rheinhalle gauge in 2024

1.3.2.3 Germany

Source: Federal Institute of Hydrology (BfG)

After two previous years characterised by low water levels, 2024 saw predominantly high discharge levels across Germany. This also applies to the Rhine and its catchment area. After the wet autumn of 2023 had already led to high soil moisture levels, frequently recurring weather patterns manifested themselves in the hydrological year 2024 in a constellation that favoured persistent, intense, widespread precipitation, especially in Central Europe. There were large-scale, prolonged periods of heavy rain, with sometimes extreme total amounts, which were additionally intensified in some phases by convective heavy rain events.

The hydrographs of the discharge process, differentiated by section into the Upper Rhine (Maxau gauge), the Middle Rhine (Kaub gauge) and the Lower Rhine (Duisburg-Ruhrort gauge) in Figures 13, 14 and 15, show that the discharge level of the Rhine was above the long-term averages (MQ) for most of the year. This reveals a highly volatile water regime: especially in winter and spring, additional flood waves occurred repeatedly in quick succession. It is clear that these often did not occur independently of one another but must be assessed as interconnected flood events with multiple peaks.

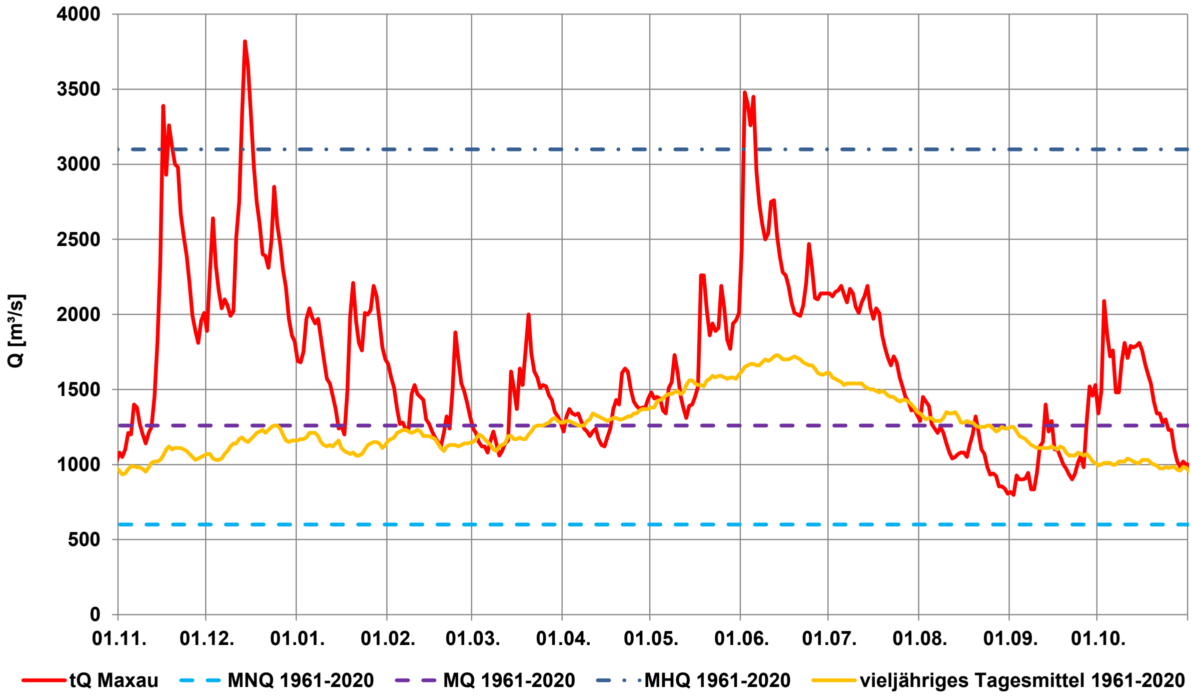

Figure 13: Daily discharge volumes (tQ) at Maxau Upper Rhine level in the hydrological year 2024 against the background of the multi-year daily average and the MNQ and MQ values for the reference period 1961 to 2020

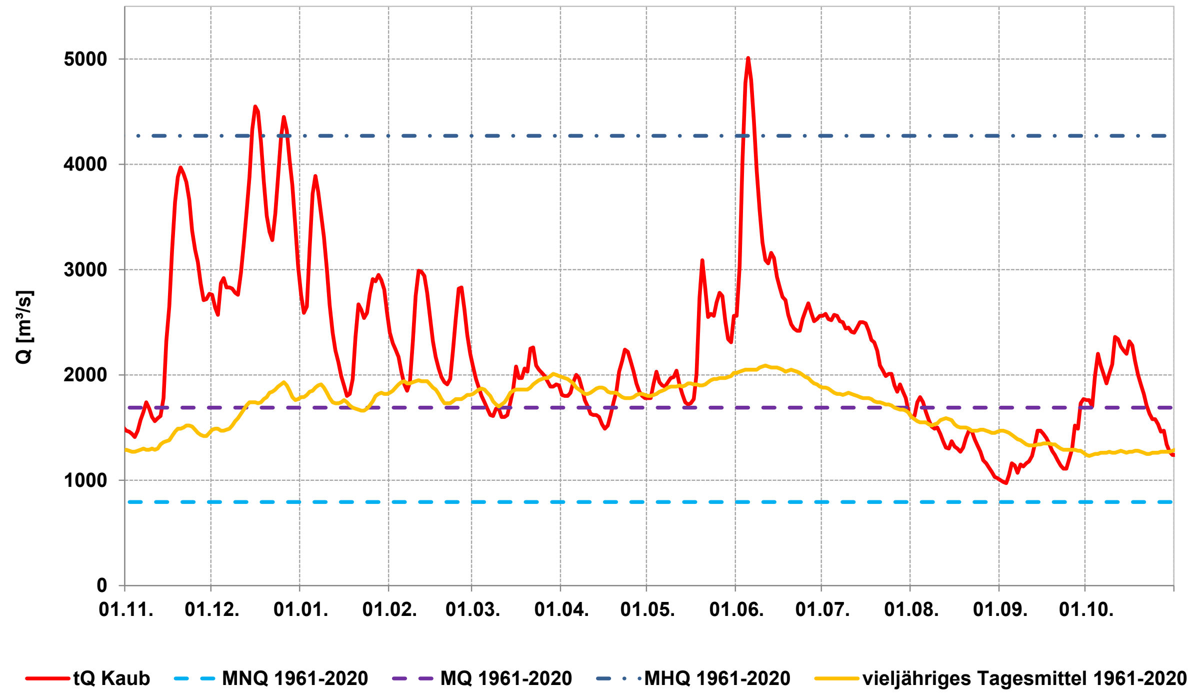

Figure 14: Daily discharge volumes (tQ) at the Kaub Middle Rhine gauge in the hydrological year 2022 against the background of the multi-year daily average and the MNQ and MQ values for the reference period 1961 to 2020

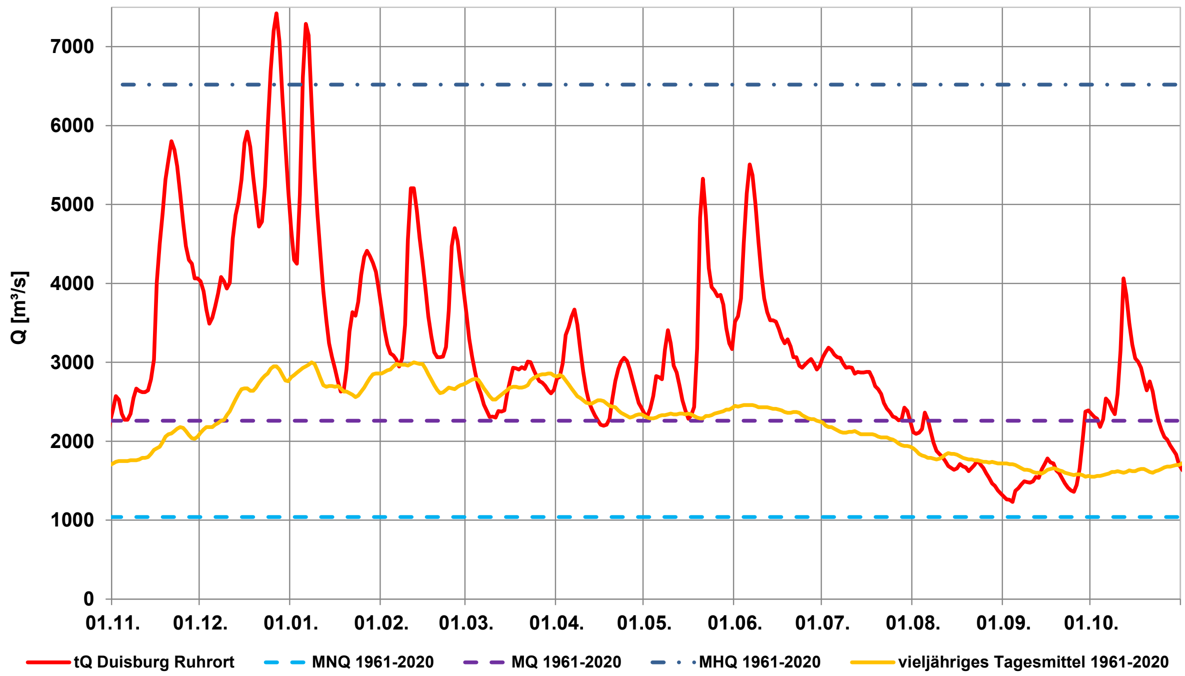

Figure 15: Daily discharge volumes (tQ) at the Duisburg-Ruhrort Lower Rhine gauge in the hydrological year 2024 against the background of the multi-year daily averages as well as the MNQ and MQ values for the reference period 1961 to 2020

November and December 2023 proved to be particularly high in terms of discharge, as did January 2024 in the Lower Rhine region. The maximum discharge levels were recorded on the Upper and Lower Rhine in the winter months of December and January, whereas on the Middle Rhine they were recorded in late spring, accompanied regionally by flood waves on the High Rhine and the Neckar, as well as by a major flood event in the western catchment area, mainly on the Saar. It was only between mid-August and the end of September that the long-term mean discharge levels (MQ) were not reached for a few weeks. However, wet weather in October prevented the Rhine's water discharge from falling below the threshold values of long-term average low water discharge levels (MNQ).

As Table 2 shows, the mean annual discharge in the various sections of the Rhine was around one third higher than the long-term averages. Not only in absolute terms, but also in relative terms, the cold season in 2024 saw significantly higher discharge levels.

Table 2: Year-round and seasonal discharge averages for the hydrological year 2023 compared to the long-term reference values for the period 1961 to 2020 at the gauges Maxau /Upper Rhine, Kaub / Middle Rhine, and Duisburg-Ruhrort / Lower Rhine (Data basis: WSV)

hydrologische Jahre	MQ(1961/2020)	MQ(2024)		SoMQ(1961/2020)	SoMQ(2024)		WiMQ(1961/2020)	WiMQ(2024)	
	[m³/s]	[m³/s]	Verhältnis zum MQ(1961/2020 [%]	[m³/s]	[m³/s]	Verhältnis zum SoMQ(1961/2020 [%]	[m³/s]	[m³/s]	Verhältnis zum WiMQ(1961/2020 [%]
Maxau	1260	1670	133%	1350	1620	120%	1170	1720	147%
Kaub	1690	2230	132%	1640	2020	123%	1740	2450	141%
Duisburg-Ruhrort	2260	3150	139%	1970	2590	131%	2550	3720	146%

Figures 13, 14 and 15 and Table 3 show that there was no significant low water level in the Rhine throughout the entire 2024 discharge year; the multi-year MNQs were not undershot.

Table 3: Average and extreme values of the discharge of the hydrological year 2024 compared to the long-term reference values for the period 1961 to 2020 at the gauges Maxau /Upper Rhine, Kaub / Middle Rhine, and Duisburg-Ruhrort / Lower Rhine (Data source: WSV)

hydrologische Jahre	MQ(1961/2020)	MQ(2024)	MNQ(1961/2020)	NQ(2024)		MHQ(1961/2020)	HQ(2024)	
	[m³/s]	[m³/s]	[m³/s]	[m³/s]	Datum	[m³/s]	[m³/s]	Datum
Maxau	1260	1670	600	797	02.09.2024	3097	3820	14.12.2023
Kaub	1690	2230	792	973	03.09.2024	4240	5010	05.06.2024
Duisburg-Ruhrort	2260	3150	1040	1230	04.09.2024	6520	7420	27.12.2023

Despite the generally high discharge capacity, flood levels exceeding the MHQ marks were only rarely reached in the Rhine (in contrast to some regional events in its catchment area), and in the Lower Rhine (Duisburg-Ruhrort gauge) only on six days of the year (Table 4).

Table 4: Days on which the long-term mean values MQ (mean discharge) and MHQ (mean high-water discharge) for the reference period 1961 to 2020 were exceeded at the Maxau/Upper Rhine, Kaub/Middle Rhine, and Duisburg-Ruhrort/Lower Rhine gauges in 2024 (Data source: WSV)

hydrologisches Jahr 2024	Überschreitungstage	
	MQ (1961/2020)	MHQ (1961/2020)
Maxau	157	10
Kaub	160	9
Duisburg-Ruhrort	141	6

Of the three representative example gauges, the peak value HQ(a) was only at the less extreme level of a five-year return interval HQ5 in the case of the Upper Rhine gauge at Maxau;

the HQ(a) values were even more moderate at the Middle and Lower Rhine sections (Table 5).

Table 5: Extreme flood events NM7Q(2023) on the Upper, Middle and Lower Rhine and their return intervals (Data source: WSV)

hydrologisches Jahr 2024	HQ [m³/s]	Wiederkehr-intervall
Maxau	3820	5
Kaub	5010	2-5
Duisburg-Ruhrort	7420	2-5

1.3.2.4 Netherlands

Source: Water Management Centre, Rijkswaterstaat (RWS)

The year 2024 was characterised by above-average discharge levels and comparatively high water levels of the Rhine at Lobith. The cause was the very wet weather conditions in large parts of the Rhine catchment area. In contrast to years with prolonged periods of low water, 2024 saw neither pronounced dry periods nor exceptionally low discharges.

In the first half of the year, the wet winter and record-breaking wet spring led to persistently high Rhine discharge levels. Especially in May and early June, heavy precipitation in Germany and in the upstream Rhine region caused increased water levels in the Netherlands. At the beginning of June, the water level at Lobith exceeded the 12 m +NAP mark and reached a peak of around 13 to 13.5 m +NAP. As a result, lower-lying riparian zones (floodplains) were inundated. Statistically, a flood wave of this magnitude in June occurs only about once every fifteen years. It was also noteworthy that two flood peaks were observed within the space of a few weeks.

After these flood events, discharge levels gradually decreased but remained mostly at or above the long-term average values during the summer. The total amount of rainfall in the summer of 2024 was roughly in line with the long-term average, meaning that the Rhine was sufficiently fed and there were no prolonged periods of low water.

Even in autumn, discharge conditions remained comparatively favourable due to the persistently wet conditions in the catchment area. Due to the high levels of precipitation throughout the year, there was hardly any precipitation deficit, while groundwater levels remained elevated in many places. This had a positive effect on the Rhine's base discharge, meaning that the river transported sufficient water to the Netherlands throughout the year.

The average daily discharge of the Rhine at Lobith for 2024 is shown in Figure 16.

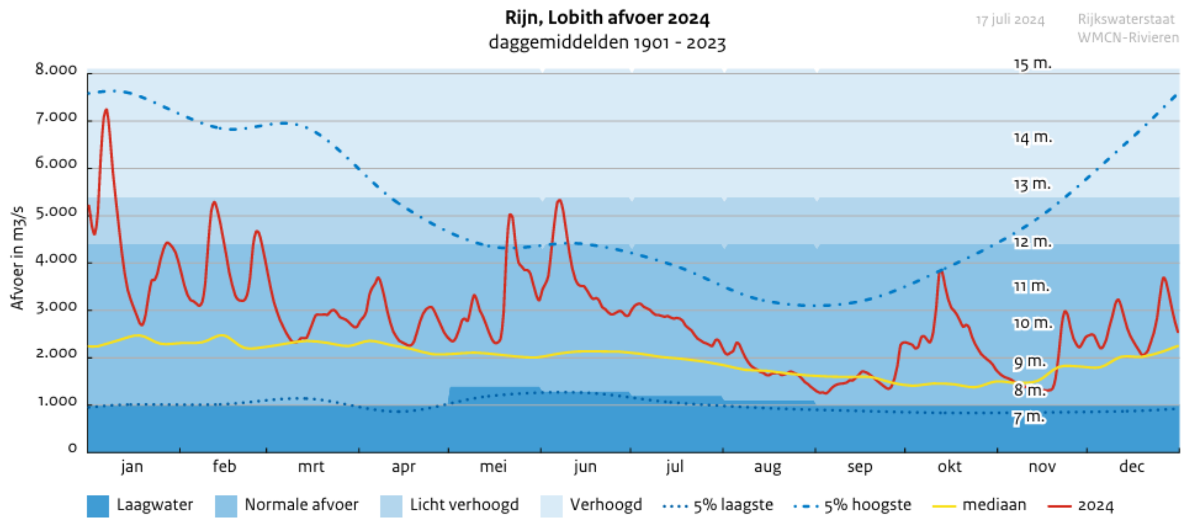

Figure 16: Hydrograph of the daily average discharge at Lobith gauge in 2024 (red curve) compared to long-term minima, maxima, and averages of 1901-2023.

1.3.3 Water temperatures

1.3.3.1 Austria

Source: Department of Water Management, Office of the Vorarlberg State Government, Bregenz

Over the year as a whole, the water temperature of Lake Constance at the Bregenz Harbour gauge was 13.6 °C, which was 1.4 °C above the long-term average of 12.2 °C. With a few exceptions, the daily mean values from the beginning of the year to the end of the year were above the daily mean values of the long-term series from 1979–2020 (see Figure 17).

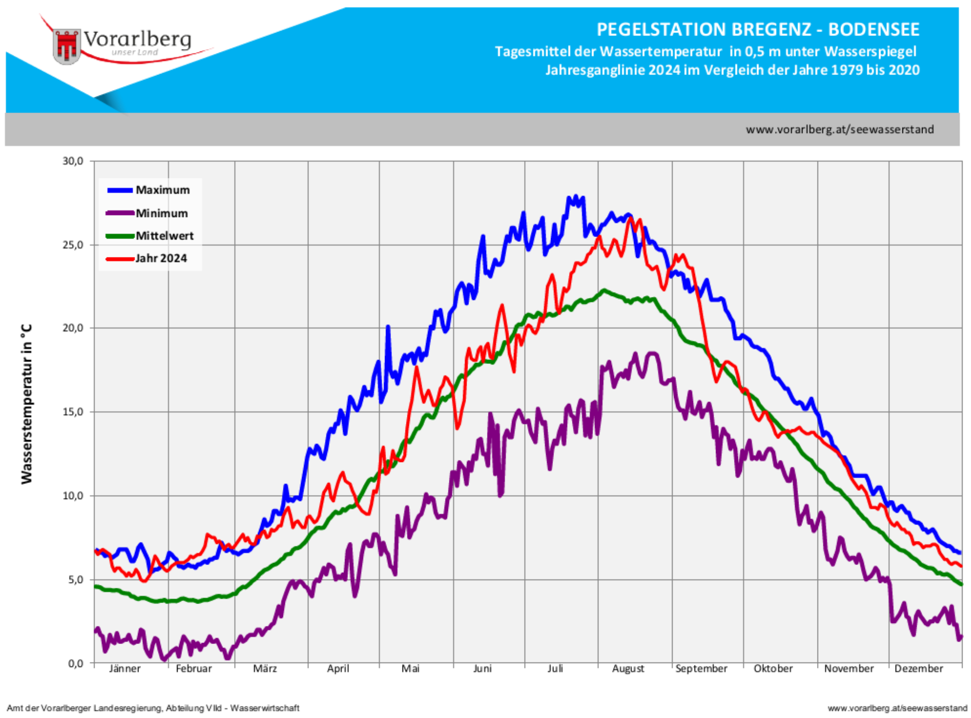

Figure 17: Hydrograph of the water temperature of Lake Constance at the Bregenz gauge in 2024 (red curve) compared to long-term minima, maxima, and mean values

1.3.3.2 Switzerland

Source: Swiss Federal Office of the Environment (BAFU)

The year 2024 was characterised by temporary warm spells in the first and third quarters of the year. However, when averaged over the whole year, this had hardly any effect, which is why only isolated new maximum values can be observed in the Central Plateau and the Alps in the annual mean values. Compared with the two previous years, the daily maximum temperatures exceeded the limit value of 25 °C less frequently. The stations where this was the case are mainly located on the High Rhine and its upper tributaries. Further exceedances can be found sporadically at stations in the Swiss Plateau and below Lake Geneva.

According to MeteoSwiss, 2023/24 saw the mildest winter in Switzerland since records began. As early as January, there were isolated instances of new monthly lows and highs in water temperatures, mainly in flowing waters in the Alps. Low water temperatures can occur during warmer periods due to snowmelt or particular local weather conditions. The record-breaking warmth in February then had a significant impact on the water temperature: new February highs were observed at over 30 stations across Switzerland. At the end of summer, in the sunny and rather dry month of August, new monthly highs were recorded at very few stations in the Central Plateau and the Alps. It was only the warm start to September that then led to new highs for this month at around 30 stations, mainly in the Central Plateau and along the Rhine.

1.3.3.3 Netherlands

Source: Water Management Centre, Rijkswaterstaat (RWS)

At the Lobith gauging station, the mean water temperature of 14.5 °C was about 1.4 °C higher than the long-term (1961–2020) calculated annual mean (Figure 18).

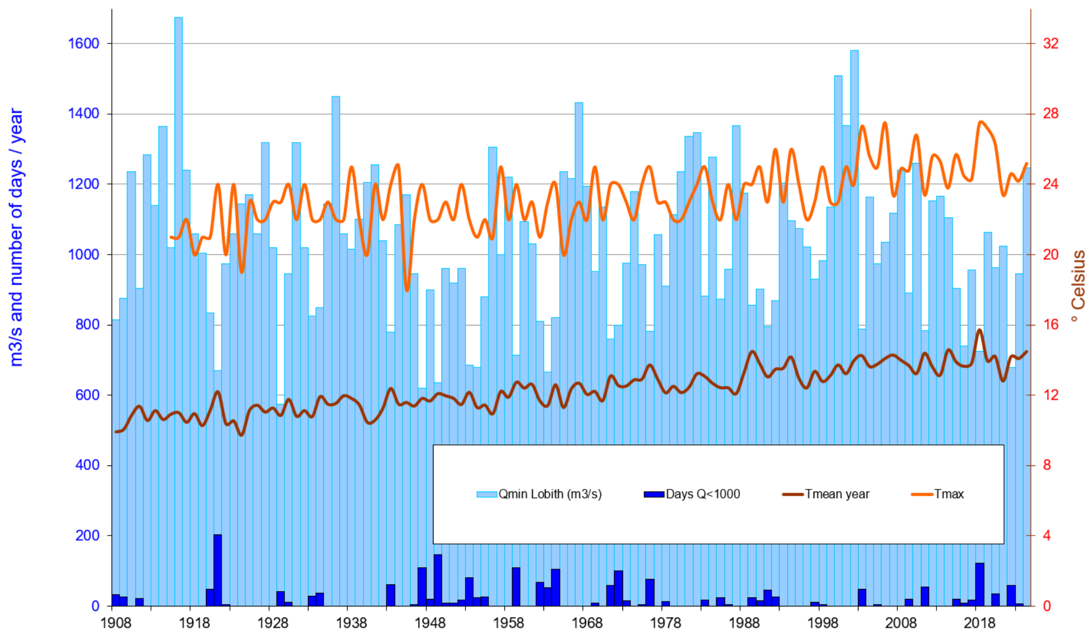

Figure 18: Average and maximum water temperatures 1908-2024 at the Lobith/Rhine gauge

1.3.4 Groundwater

1.3.4.1 Austria

Source: Department of Water Management, Office of the Vorarlberg State Government, Bregenz

In 2024, groundwater levels in the Austrian part of the Rhine basin were above the long-term averages. At the end of May/beginning of June, a flooding event caused a rapid, sharp increase, especially in the Lake Constance area. In the second half of the year, groundwater levels fell slightly again, returning to the range of long-term averages.

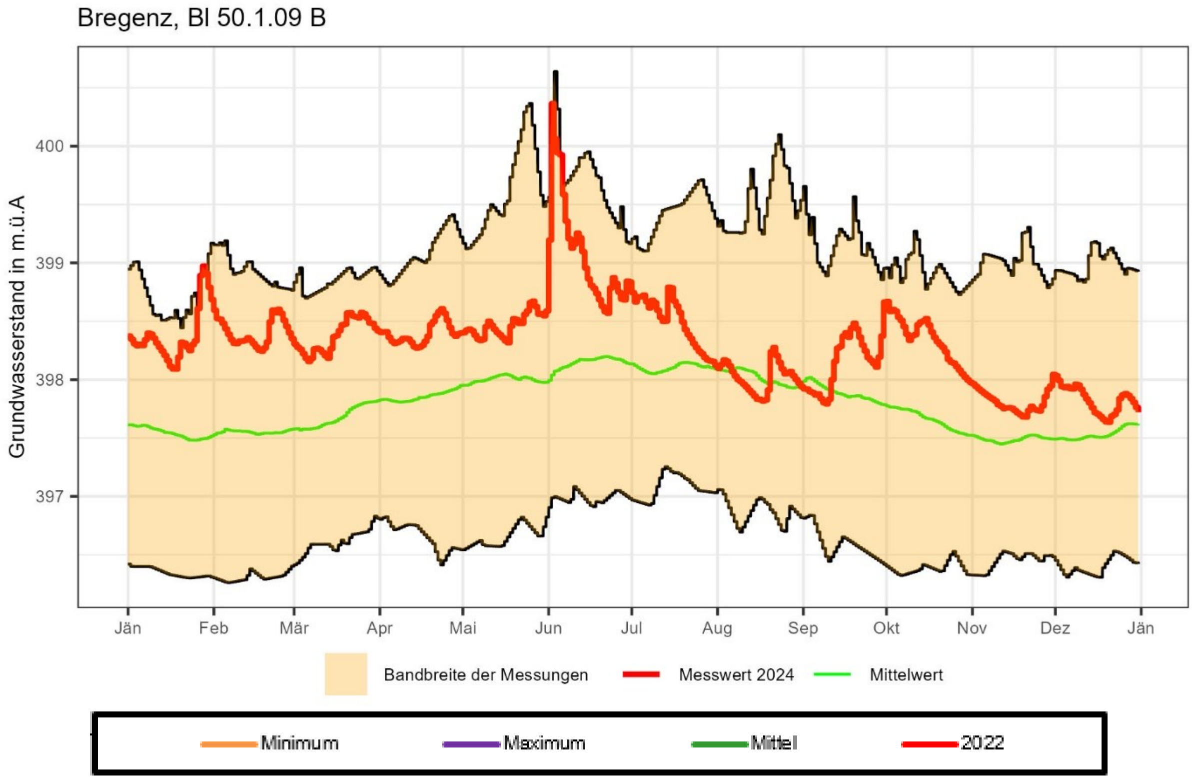

Figure 19: Hydrographs of the groundwater level in 2024 compared with long-term minima, maxima, and mean values (1964 – 2023) Bregenz measuring point, folio 50.1.09 B

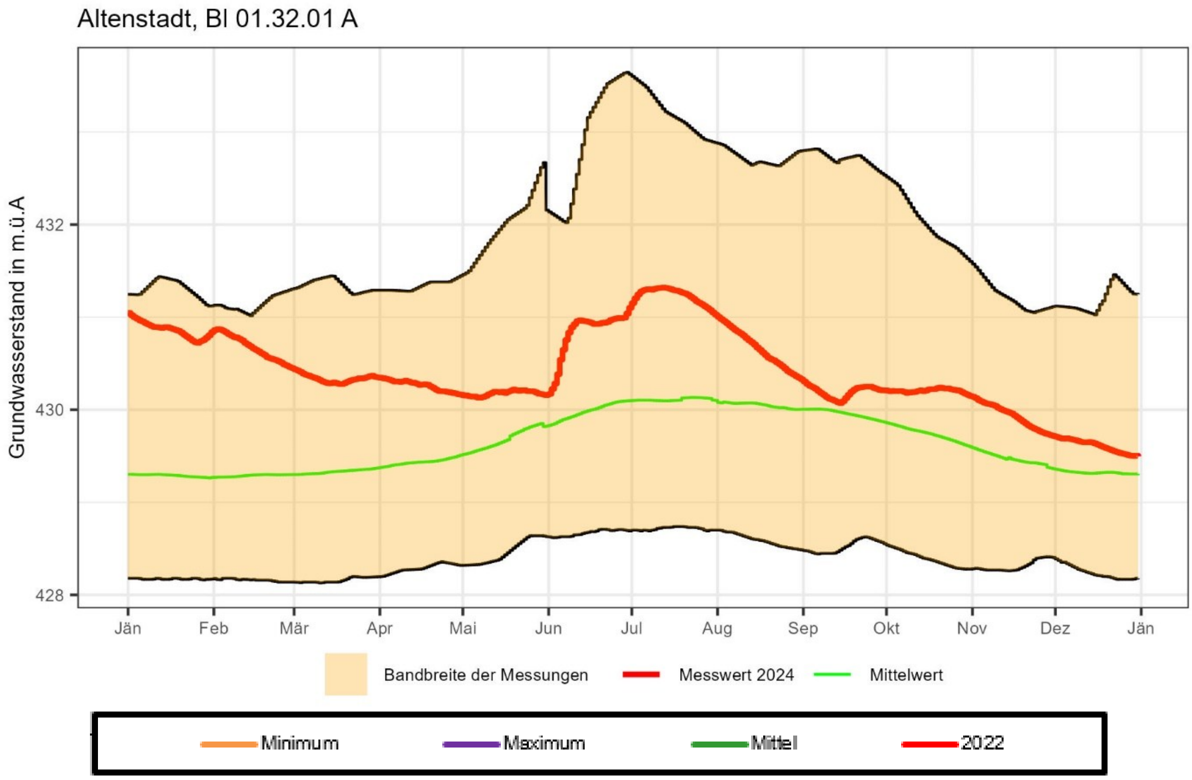

Figure 20: Hydrographs of the groundwater level in 2024 compared to long-term minima, maxima, and mean values (1962 – 2023) Feldkirch-Altenstadt measuring point, folio 01.32.01 A

1.3.4.2 Switzerland

Source: Swiss Federal Office of the Environment (BAFU)

Based on the multi-year weather patterns (temperature and precipitation), longer periods with rather low or rather high groundwater levels can often be identified in Switzerland's groundwater. In this respect, the year 2024 falls within a period that, when compared over many years, shows predominantly high groundwater levels and spring discharges.

Due to the above-average rainfall from January to June 2024, high groundwater levels and spring discharges were observed at around every second measuring point throughout these months. Groundwater levels and spring discharges both rose, especially during heavy rainfall. This was the case, for example, at the end of May and the beginning of June in Eastern Switzerland and on 20/21 June on the southern side of the Alps and in the southern Valais valleys.

In July and August, below-average rainfall was widespread. During this period, groundwater levels and spring discharges fell, especially in near-surface groundwater aquifers. For example, at the end of August, individual smaller, shallow groundwater resources in eastern Switzerland recorded low groundwater levels and spring discharges.

In the first half of September, exceptionally large amounts of snow fell at higher altitudes. The mild temperatures that followed quickly caused the snow to melt. As a result, groundwater levels and spring discharges increased. In October, for example, high groundwater levels and spring discharges were observed at every second monitoring point.

The onset of winter at the end of November brought heavy snowfall on both sides of the Alps, even at low altitudes. There was also plenty of fresh snow at higher altitudes shortly before Christmas. In Ticino and Grisons, on the other hand, it was dry in December. In November and December, high groundwater levels and spring discharges were still recorded at one in three monitoring points.

1.3.5 Suspended matter

1.3.5.1 Austria

Source: Department of Water Management, Office of the Vorarlberg State Government, Bregenz

At approximately 4.50 million tonnes, the annual suspended solids load in the Alpine Rhine at the Lustenau measuring station in 2024 was significantly higher than the average for the 2010–2023 time series (approximately 2.2 million tonnes). The highest monthly freight volume was recorded in June, at approximately 2.10 million tonnes. This corresponds to approximately 47% of the total annual load.

The largest daily freight volume was determined to be around 371,000 tonnes (approx. 8% of the annual freight volume) on 22 June (see Figure 21).

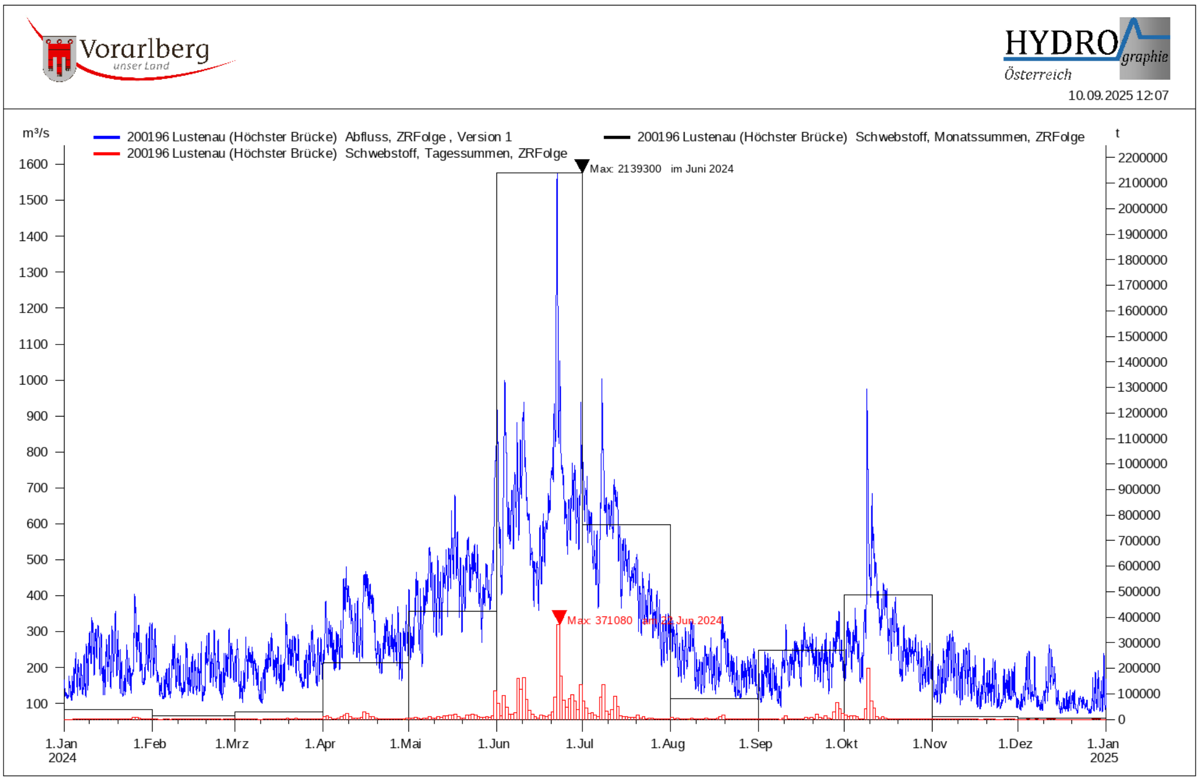

Figure 21: Monthly suspended solids loads of the Alpine Rhine at the Lustenau gauge in 2024 with day loads (red curve) and discharge hydrograph (blue curve).

2. Activities of the International Commission for the Hydrology of the Rhine Basin (CHR) in 2024

CHR meetings
Two official CHR plenary meetings took place in 2024. The spring meeting (No. 93) was held on 3-5 April March in Koblenz, Germany. The autumn meeting (No. 94) took place on 28-29 October in Lochau, Austria.

Figure 22: CHR members at the 2024 autumn meeting (94) at Lochau, Austria.

Personnel changes within the CHR
Mr. Clemens Mathis (Vorarlberg, Austria) has been retired since early 2024. His CHR successor in Vorarlberg is Mr. Armin Matzl.
Mr. Helmut Habersack has been re-elected as CHR President for a further three years (2024–2026). No other personnel changes took place in 2024.

Ongoing activities in CHR projects

Climate change: the Rheinblick2027 project has been launched
In 2024 we launched our project Rheinblick2027 as the successor to the CHR Rheinblick2050 study from 2010-2011. The project is like the previous Rheinblick, namely focusing on future discharges considering actual datasets, multiple available hydrological models (Wflow, Prevah, Larsim) and the latest climate scenarios (KNMI and CORDEX). In addition, attention will be paid to several additional themes such as stress test scenarios, flash floods, groundwater, extreme events, sea level rise, and the Meuse (regarding the delta area). In Apil the CHR organized a stakeholder workshop at the ICPR secretariat in Koblenz, bringing together representatives from Rhine basin organizations, water authorities, and Rhine commissions to discuss project objectives, user needs, and future climate scenarios to be used. Halfway through the year, two Swiss project coordinators (from University Zurich and WSL) were hired through 2027 to manage the Rheinblick project. Subsequently, starting in the fall, an international consortium was formed, comprising hydrologists and water management experts from institutions such as Del-

tares, WSL, BfG, INRAE, KNMI, LUBW, and others, to start working on updated Rhine discharge projections and new modelling frameworks. The first substantive results are expected in 2025.

Socio-economic Scenarios (SES) and influences on the low-water regime of the Rhine
In 2024, CHR continued work on its Socio-Economic Scenarios (SES) Project, which examines how future socio-economic developments and changing water demand may affect Rhine basin water availability and drought risk under climate change. Three shared scenario narratives (Sustainable Community, Middle of the Road, and Economic Growth) were elaborated and translated into quantitative assumptions on water demand. Using the Wflow-RIBASIM modelling framework, the project assessed the impacts of socio-economic change and climate change on Rhine basin water balances, low flows, drought risk, and water allocation.
Like previous years, the SES project works closely with the Stars4Water project, which has been running since 2022. The Stars4Water project provides support for several components of the SES project. More information about Stars4Water can be found below.

Sediment
The CHR participated in the international Rhine sediment workshop in Strasbourg in June 2024, where representatives of the Rhine commissions, authorities and scientific institutions developed a shared understanding of sediment balance and management challenges. The outcomes identified priorities for improved monitoring, data sharing and transboundary cooperation and provided an important foundation for future basin-wide sediment initiatives such as sediment management plan. In addition, a CHR sediment task force was established, comprising sediment experts from the Rhine River basin. This group met in the fall to share knowledge and discuss desired follow-up CHR research for the coming years. The focus is on system-level understanding, ensuring a balanced sediment budget, and trends in morphology.

Hydrological Memory of the Rhine
In 2024, CHR supported research on the Hydrological Memory of the Rhine through cooperation with the University of Bonn and the German Federal Institute of Hydrology (BfG).

CHR Information System
In 2022 a first version of a prototype of the CHR information system was developed by the German company Terristris. The prototype includes a first set of (historical) map material including a set of time series of a number of measurement sites along the Rhine. In 2024, the CHR further coordinated internally on how to take the next step toward a public-friendly version. The steering committee met several times for this purpose. No further development of the information system took place in 2024. This is planned for 2025.

Stars4Water
The 4-year Stars4Water project was launched at the end of 2022. Funded by the European Horizon Framework Programme, this collaborative project aims to increase understanding of the impacts of climate change on water availability and vulnerability to ecosystems, society, and the economy at river basin scale. Within the project, a consortium led by Deltares is working together within 7 different river basins in Europe to develop, among other things, models, information systems, and data sets. Several CHR organisations are active in the consortium. The project may also provide an opportunity to support certain CHR projects such as the SES project where work can be done to improve the RIBASIM model or work out social economic scenarios. Since 2022, the CHR has as well designated a member to participate in the advisory board of the Stars4Water project.

Strategic Orientation of the CHR
Also in 2024, CHR operates in line with its strategy set for the period 2020-2030.

Public Relations
The CHR participated and contributed in 2024 to:
- Water Symposium Oberrhein (March, multiple locations)
- The international Rhine sediment workshop (June, Strasbourg; organized by the ICPR).
- Conference on Inland Ports and Climate Adaptation (June, Strasbourg)
- Annual Stars4Water meeting (September, Spain)

Publications of the CHR
The CHR has published:
- the Hydrological Annual Report 2023 for the Rhine region in two languages.
- Sediment paper published in journal Water