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

CHR Annual Report 2009

Edited by: Eric Sprokkereef

Contributors: Martin Barben – Federal Office for the Environment, Bern
Jörg Belz – Federal Institute of Hydrology, Koblenz
Mïchael Mürlebach - Federal Institute of Hydrology, Koblenz
Alessandro Grasso - Federal Office for the Environment, Bern
Adrian Jakob - Federal Office for the Environment, Bern
Clemens Mathis – Office of the State of Vorarlberg, Bregenz
Marc Schürch - Federal Office for the Environment, Bern
Stephan Bader, MeteoSwiss, Zurich

Secretariat of the CHR
PO Box 17
8200 AA Lelystad
The Netherlands
Email: info@chr-khr.org
Website: www.chr-khr.org

International Commission for the Hydrology of the Rhine Basin

The International Commission for the Hydrology of the Rhine Basin (CHR) operates within the framework of the UNESCO International Hydrological Programme (IHP) and of the WMO Hydrology and Water Resources Programme (HWRP). 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:

- Federal Ministry for Agriculture and Forestry, Environment and Water Management, Department VII/3 – Hydrologic Balance (Central Hydrographical Bureau), Vienna, Austria
- Office of the State of Vorarlberg, Department VIId – Water Management, Bregenz, Austria
- Federal Office for the Environment, Bern, Switzerland
- CEMAGREF, Antony, France
- Federal Institute of Hydrology, Koblenz, Germany
- Hessian State Office for Environment and Geology, Wiesbaden, Germany
- IHP/HWRP Secretariat, Federal Institute of Hydrology, Koblenz, Germany
- Administration de la Gestion de l'Eau, Luxembourg
- Deltares, Delft, the Netherlands
- Rijkswaterstaat – Centre for Water Management, Lelystad, the Netherlands.

1. Hydrological Overview for the Rhine Basin

Meteorological Characteristics

In Austria, the air temperature in 2009 was on average ca. 1.0 °C above the mean.

The first weeks of the year 2009 were characterized in Switzerland by wintery conditions. Above all, the duration of the snow cover led in the lowlands of the northern side of the Alps to the impression of a long winter. Ticino also experienced a winter with frequent snowfall and deep accumulation. With one stroke, April then brought spring or nearly summer to Switzerland. The sustained high temperatures led one to believe it to be rather the end of May or beginning of June, especially in the northern lowlands. The summer of 2009 presented itself changeable for long periods. Lasting summer weather asserted itself only in August. In the fall, the dryness of the months of September and October was the decisive weather element, already preceded by an August low in precipitation. After a long-lasting lack of alpine snow in early winter, Switzerland received significant snowfalls promptly at the meteorological beginning of winter.

On the night of New Year's Eve it began to snow lightly in many places. Together with the below-average temperatures that lasted into the middle of January, Switzerland was thus granted a wintery start to the year. The Bern region experienced an especially wintery turn of the year 2008/09: Two intensive snowfall events in December 2008 and the subsequent temperatures mostly under the freezing point provided here for an unusually long phase of snow cover from December 10, 2008, to the end of February 2009. Above all, the duration of the snow cover has led in the lowlands of the northern side of the Alps to the impression of a long winter. Ticino also experienced a winter with frequent snowfall with deep accumulation. Locarno-Monti registered sixteen days with new snow through the end of February.

Since 1935 there have been only three winters here with more days of new snow. Moreover, the winter is one of the coldest of the last twenty years. Typical for our winter climate were the two winter storms "Joris" of January 23 and "Quinten" of February 10, 2009. "Joris," in particular, swept violently across Switzerland; it even reached an unusually high peak wind of 155 km/h in Cressier between Lake Neuchâtel and Lake Biel.

Even in March the weather remained distinctly winter-like with repeated snowfalls with deep accumulation. Truly mild spring days failed to materialize in March on the northern side of the Alps, owing not least to an often persistent north wind.

All at once, April then brought spring or nearly summer to Switzerland. The sustained high temperatures led one to believe it to be rather the end of May or beginning of June, especially in the northern lowlands, so mild was the weather. Switzerland experienced the fourth warmest April since the beginning of regular measurements in the year 1864. With the great warmth, however, came also a pronounced dry spell. Heavy rains then occurred in the last days of April on the southern side of the Alps and in parts of Valais as well as in the Bern highlands and Surselva. In high elevations these storms still produced significant snowfalls.

The fourth-warmest April was followed by the second-warmest May since the beginning of measurements. In the last third of the month, the daily highs in the lowlands climbed widely to midsummer-like temperatures around 32 °C, higher still in the Foehn valleys. The highest temperature was reached in Sion with 35.1°. Little wonder that this persistent above-average heat finally led to the second-warmest Swiss spring. Warmer still, however, was the record spring of 2007.

As if Switzerland had already richly received its share of summer in the spring, the Swiss summer of 2009 presented itself changeable over long periods as if in compensation. Above all, June and July were characterized by frequent temperature swings. Summer-like warm days were followed immediately by passing disturbances with cold fronts, which (interestingly enough) often fell on weekends. But the temperatures fell mostly only to normal or slightly below normal. July showed itself wet overall and especially in the south with violent storms. In Lugarno, the rainfall total of 397 mm was the highest for July since the beginning of measurements in the year 1864; two storms alone brought 73 mm (15/07/09) and 99 mm (17/07/09) of rain, each time in the space of only three hours.

Lasting summer weather asserted itself only in August. The hottest phase of the year occurred between August 12 and August 21. Again extremes for the month were reached during this period: Averaged over the whole of Switzerland, August 2009 was the third-warmest since the beginning of measurements. These were warmest dates since the hot summer of 2003.

There was already a nationwide rain deficit in August 2009. In broad areas the rainfall amounts were less than 60% of normal, regionally even less than half. The same was true in September and somewhat less accentuated in October. The pronounced dryness occurred with mild temperatures in September and the beginning of October. Again extremely mild was November 2009. A significantly higher monthly average was previously reached only in November 1994, and similarly mild was the November of the record fall of 2006.

After a first onset of winter in the mountains on October 12, 2009, further snowfalls were a longer time in coming. In the mild November weather, the October snow melted completely even in the highest elevations. With a strong southern current, intensive snowfall set in on November 29 on the southern side of the Alps in higher elevations. The next day an influx of cold air from the west brought a snow covering to the northern side of the Alps as well, here as low as the lowlands. The whole Swiss alpine region received significant snowfalls. At the beginning of December, the snowpack widely reached 100 to 150% of the amount usual for this time of year; in the Central and Southern Alps, it was over 200%. Then on December 20, arctic air allowed the low temperatures in the low-lying areas on both sides of the Alps to sink to -12° to -17 °C. The La Brévine station registered the coldest temperature of the year 2009 with -34.2°. There followed a swift re-warming with a southern Föhn in the north and heavy snowfalls even into the low elevations on the southern side of the Alps.

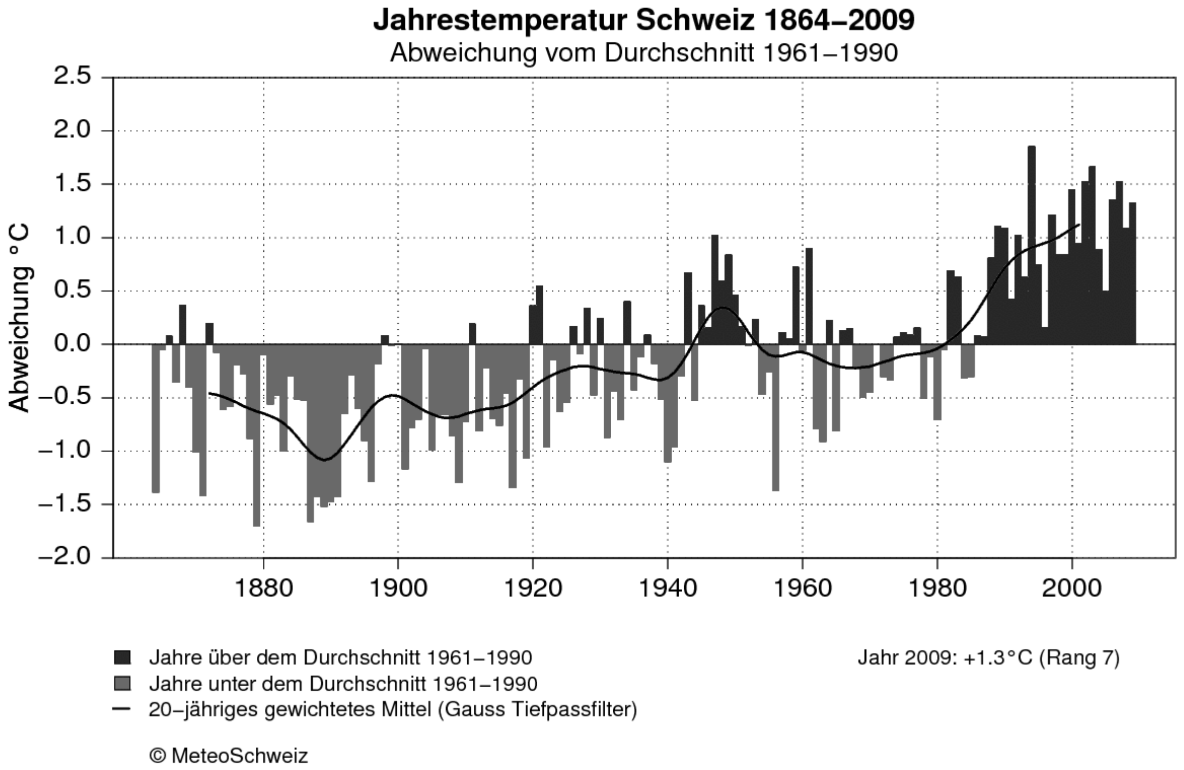

Figure 1: **The annual temperature deviation in Switzerland from the long-term average (norm 1961-1990). The above-average years are shown in dark grey, the below-average years in light grey. Solid line: 20-year weighted average.**

The year 2009 was, according to the records of the German Weather Service (GWS Weather Report Express 2009), too warm almost everywhere in the Rhine basin for the thirteenth year in a row. In particular, April was the warmest April since the beginning of regular weather records, with a positive deviation of 4.5 K. Across Germany, the yearly average temperature was 0.9 K above average. While the sunny January was considerably too cold, February distinguished itself with heavy snowfalls. The precipitation in the Rhine basin in the months of February and March was on average 120% of the observed average for the years 1961-1990 as well as twice as high as that of the three preceding months. All in all, the observed precipitation received during the discharge year (Nov. 08 – Oct. 09) for the whole Rhine drainage basin was an average of 86% of the long-term average rainfall. The division of precipitation between the winter and summer half-years showed with 44% to 56% a significant surplus of summer rainfall compared to the long-term observed precipitation division (winter 48.5%, summer 51.5%).

In the Netherlands also, with an average annual temperature at De Bilt of 10.5 °C (normal is 9.8 °C), the year 2009 was the thirteenth too-warm year in a row.
The year began cold; with a median temperature of 0.8 °C (compared to a normal 2.8 °C), January was the coldest month since 1997. The lowest temperature was recorded on January 6 with -20.8 °C in the south of the country.
A cold January was followed by ten months with above-average temperatures.
Above all, the months of April and November were unusually warm; April had a median temperature of 12.2 °C, whereas 8.3 °C is normal, making it the second-warmest April since measurements began in the year 1706.
The summer was too warm for the ninth time in a row. In the south of the country, the highest temperature was recorded on August 20 with a high of 37.0 °C.

The fall was the third warmest since 1901. With a median temperature of 9.5 °C, November was especially mild. The year ended cold again.

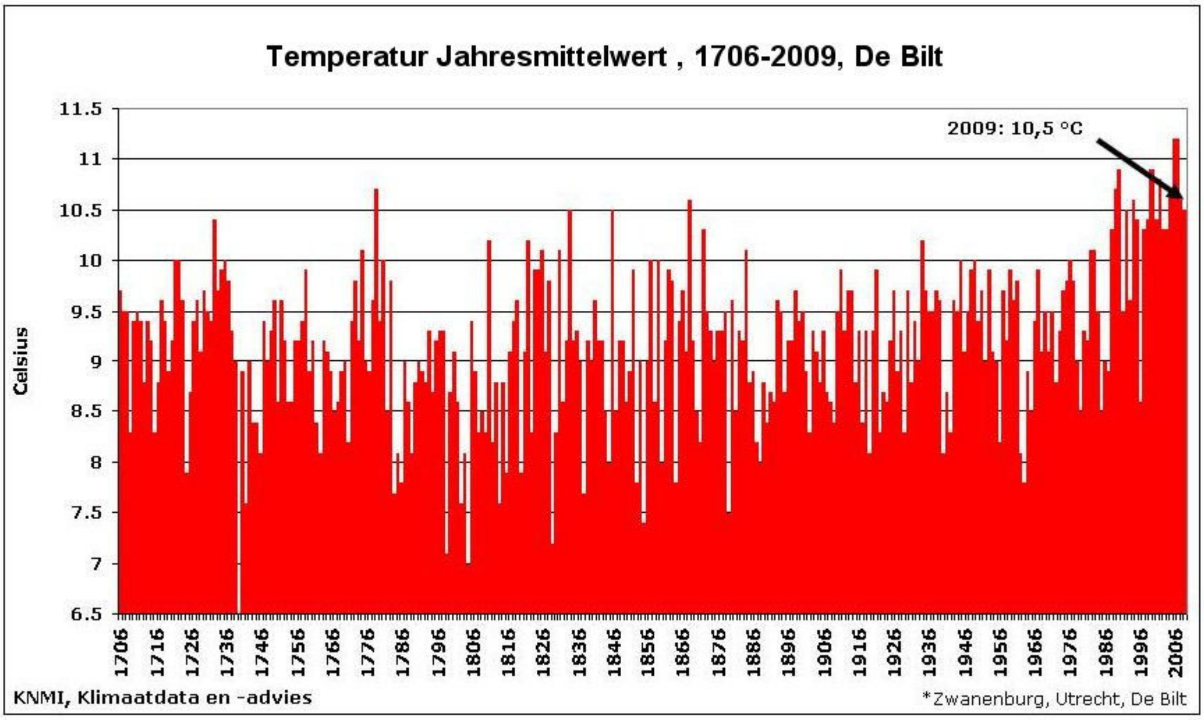

Figure 2: Yearly Average Temperatures at Station De Bilt / Netherlands from 1706 to 2009 (Source: KNMI).

Hydrological Situation in the Rhine Basin in the Year 2009

Water Levels in the Major Lakes in the Drainage Basin of the Rhine

At Lake Constance the water levels at Station Bregenz, with the exception of the period from the end of March to the end of May (snow melt in the Alps) and at the end of the year (thaw), were below the usual daily median levels for the observation period 1864 – 2007 (see Figure 3).

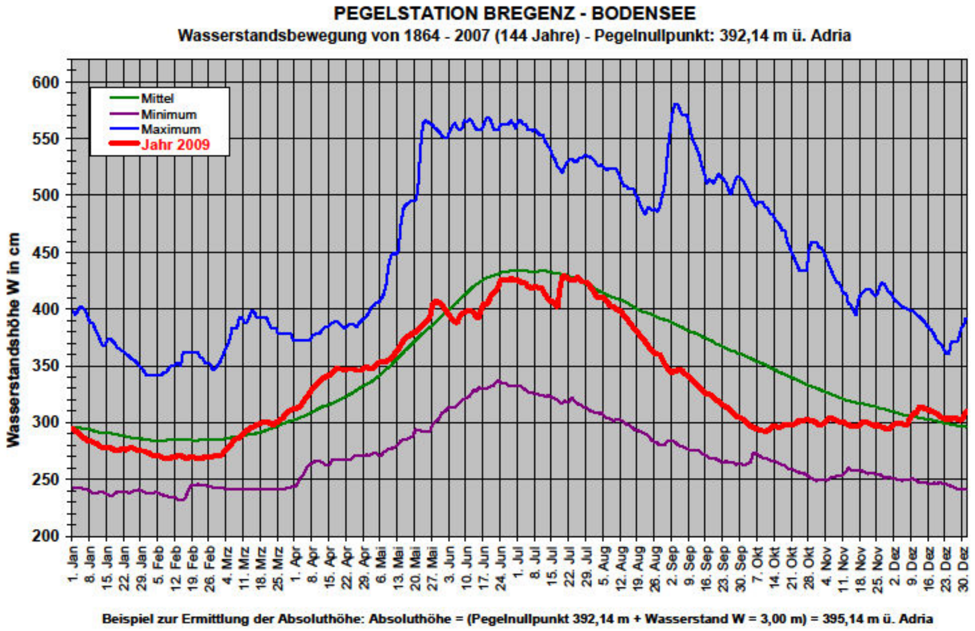

Figure 3: **Water Level Measurement Station Bregenz/Lake Constance. Water level changes of the year 2009 and main values for the period 1864 – 2007 (144 years) – Water gauge zero level: 392.14 m above the Adria.**

Water Levels and Outflow of the Flowing Waters

The annual precipitation total in the Austrian portion of the Rhine drainage basin fell within the bounds of the long-term average. While little precipitation fell in January and April, February and March were characterized by above-average precipitation. The outflow of the most important tributaries to Lake Constance fell within the average range in 2009.

- At the Bregenz station with 97% (MQ 2009 = 45.0 m³/s, long-term MQ = 46.3 m³/s);
- At the Alpine Rhine with 97% (MQ 2009 = 222 m³/s, long-term MQ = 230 m³/s).

According to the climate report of MeteoSwiss, the year 2009 mostly brought somewhat less precipitation than the average from 1961-1990. The annual outflow in the Rhine at Basel was 90% of the long-term average. There was no month that was significantly too wet in the entire Rhine drainage basin. There were, however, months in which overall strongly below-average outflows were registered. The monthly averages for September and October were widely below 75% of the normal outflows. In isolated areas they barely reached only 40%.

Really big events did not occur in the year 2009. In July the outflow in Basel reached close to 3000 m³/s (Fig. 4), an event with a period of recurrence of about two years.

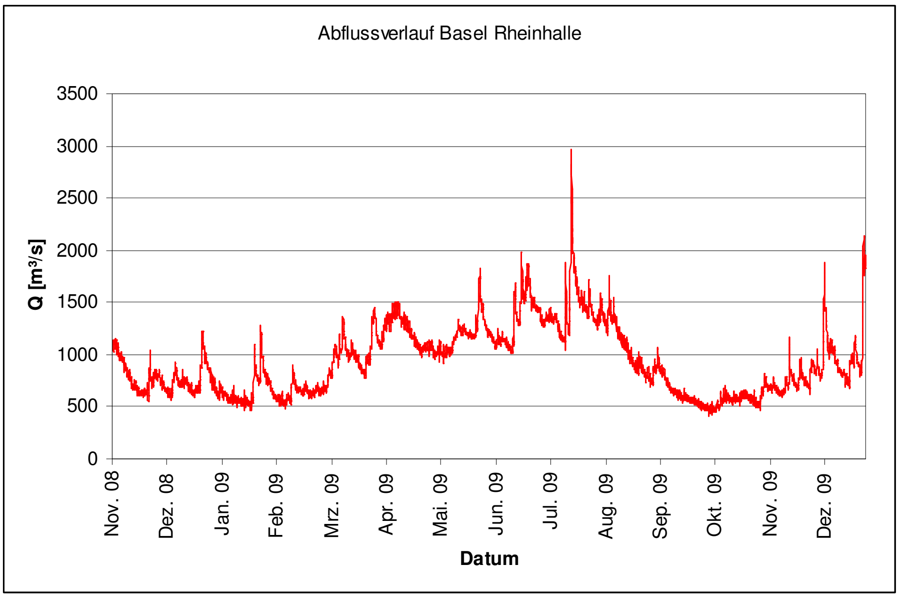

Figure 4: Outflow Hydrograph at Station Basel-Rheinhalle (Rhine) in Year 2009 in m³/s.

To a great extent, Lake Constance showed normal water levels up to the end of the summer. In September and October – as previously stated – low inflows became significantly observable. Through the end of the year, the water level gauge at Lake Constance returned to normal levels.

The outflow amounts of the major tributaries in the upper half of the Middle Rhine (Neckar and Main) lay within an order of magnitude of the long-term average, so that here normal ratios can be spoken of. The Mosel fell significantly outside the norm; the flow in the middle in the second half of the year was merely 95 m³/s., as opposed to 166 m³/s. in the years 1946-2009 — only 57%.

For the Rhine current itself, the annual course of the outflow at the observed water level gauges reflected the ratios that resulted from the precipitation, only countered because the deviations from the long-term average in the surface waters were disproportionately stronger. On consideration of the half-yearly outflow portions, in the winter in the Upper and Middle Rhine there was a roughly 6% lower outflow total, at the Lower Rhine (Station Cologne) even a deficit of 11% appeared compared to the long-term calculated amounts. Significantly less water continued to flow in the summer half-year (May-Oct.): In the middle the half-year totals at the three Rhine stations mentioned here fell to around 15% below the long-term average outflow totals.

The station Maxau (Fig. 5), most extensively marked by the nival outflow characteristics of the Alps as well as by the inflows from Lake Constance and further artificial and natural reservoirs, in the first nine months showed a very steady flow in the course of the year before even here a significant drop of the mMQ (monthly average outflow) was observed. The division of the long-term observed mean values in Maxau (MQ Winter 1150 m³/s. / MQ Summer 1360 m³/s.) shows a significant deficit, especially in the summer half-year, when compared to the means calculated in the year 2009 (MQ Winter 1070 m³/s, MQ Summer 1130 m³/s). The outflow fell short of the long-term average monthly MNQ (mMNQ) at Station Maxau in the winter half-year altogether on 25 and in summer on 90 days. The significant shortfall in the summer half-year was caused primarily by the lack of rainfall in August and September; only 49% of the normal rainfall amounts for this period were measured.

In further current flow, the influx from the low mountain ranges is increasingly shown to advantage; the nival influence vanishes, and the outflow regime increasingly retains pluvial traits. With reference to half-years, here there are usually higher outflow averages in the winter season than in the summer half-year.

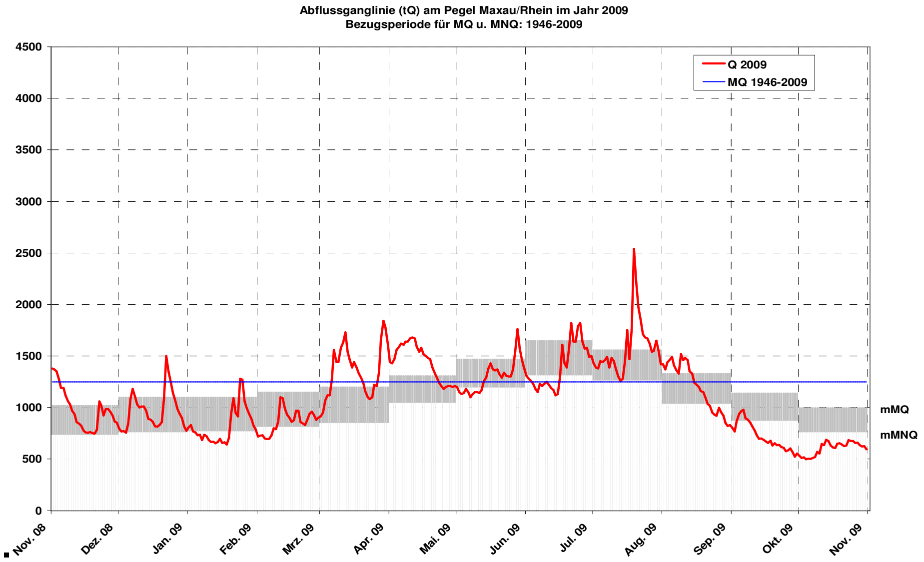

Figure 5: Outflow Hydrograph (tQ) at Station Maxau (Rhine) in Year 2009 in m³/s
(Reference period for MQ, mMQ and mMNQ: 1944-2009)

In the year 2009 a marked division between the winter and summer half-years became apparent in the course of the daily outflow of the Rhine and its tributaries below the mouth of the Neckar.

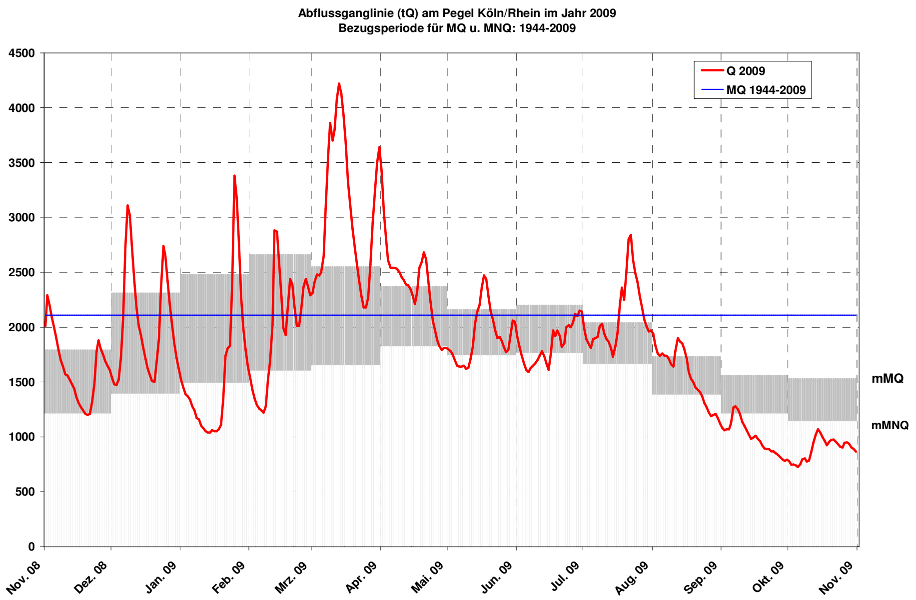

Figure 6:Outflow Hydrograph (tQ) at Station Cologne (Rhine) in Year 2009 in m³/s
(Reference for MQ, mMQ and mMNQ: 1944-2009)

Figure 6 also shows the outflow hydrograph at Station Cologne: If the winter half-year was characterized by a steady up and down of the water levels without considerable high tides, the summer was characterized by constantly falling water levels with the exception of July, which was marked by significantly higher than average precipitation. Especially in the last quarter of the flow year (Aug. – Oct.), the water levels fell strikingly. For this period the low tide flow fell below the monthly average low tide flows (mMNQ) in Kaub and Cologne on average on 63 days, at Station Cochem as many as 75 days.

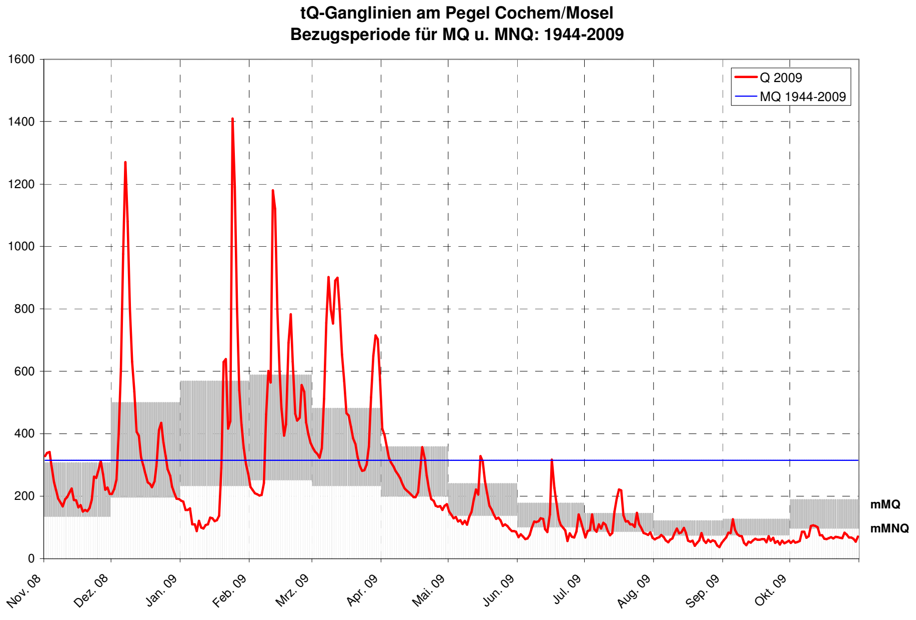

Figure 7: Outflow Hydrograph (tQ) at Station Cochem (Mosel) in Year 2009 in m³/s.
(Reference period for MQ, mMQ and mMNQ: 1944-2009)

Figure 7 explains the special situation at Station Cochem/Mosel. As the reader can see, the median annual outflow of 315 m^3/s. was exceeded only on eight days after April 1.

Water Temperature

The annual average water temperature of Lake Constance, which was 12.5 °C, was significantly higher than the long-term median of 10.4 °C. From August 6 to the end of the year, the water temperature was below the long-term median value for each calendar day on only five days in December. In particular, August, September and October set new record values for individual calendar days.

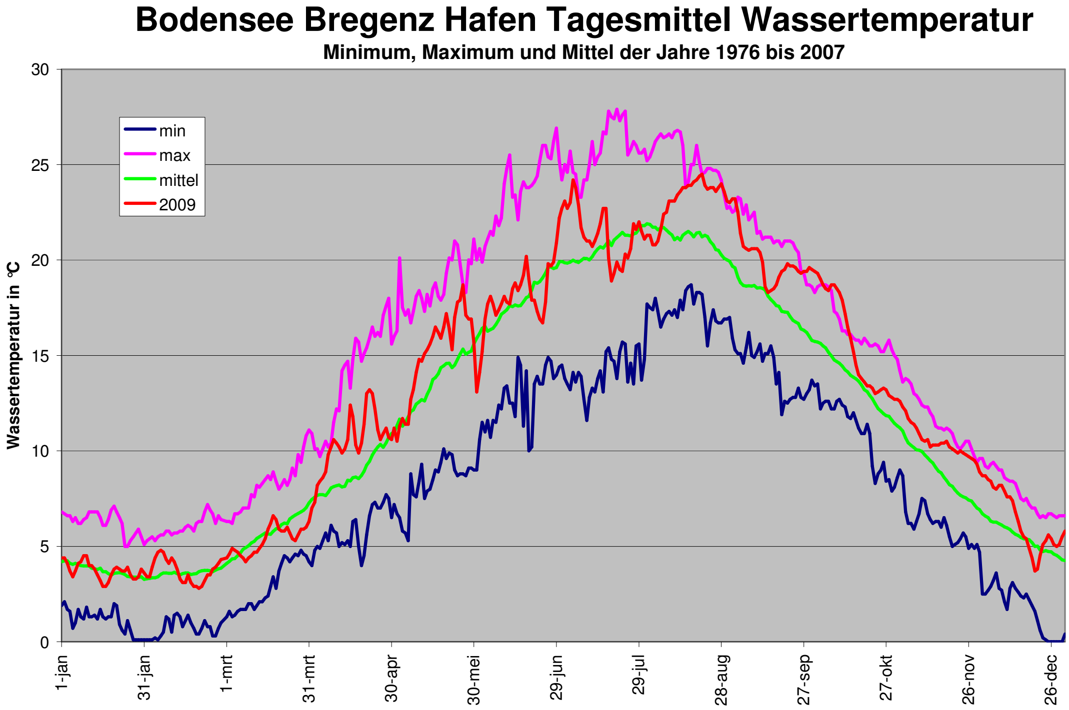

Figure 8: 2009 Water temperatures of Lake Constance at Station Bregenz in long-term comparison

The annual median values of the water temperature of the midland rivers for the year 2009 were in record high territory (see Fig. 9). Considered in part, the second-highest values since the beginning of records were maintained after the year 2003. For the corresponding times of year, above-average temperatures were recorded in the months of April, May, June, the second half of August and September. Only in the month of July and the beginning of August did the rivers demonstrate merely average temperature. The changeable weather with frequent rain storms allowed the water in this time to warm less severely. In the months of January, February and December, below-average temperatures were recorded.

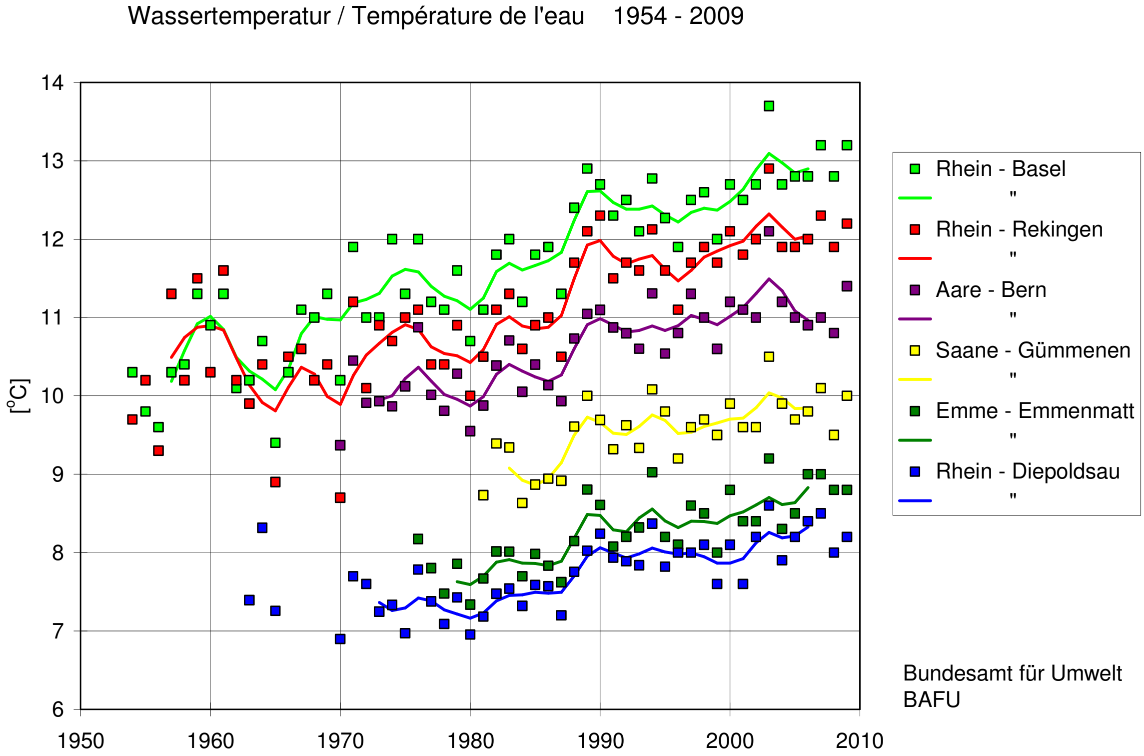

Figure 9: **2008 Water temperatures at several Swiss stations in long-term comparison**

At Station Lobith/Rhine the median water temperature for the year 2009 presented the twelfth-highest value since 1900 (see Fig. 10). Both the median annual temperature and the maximum value for the year 2009 fit the trend of previous years.

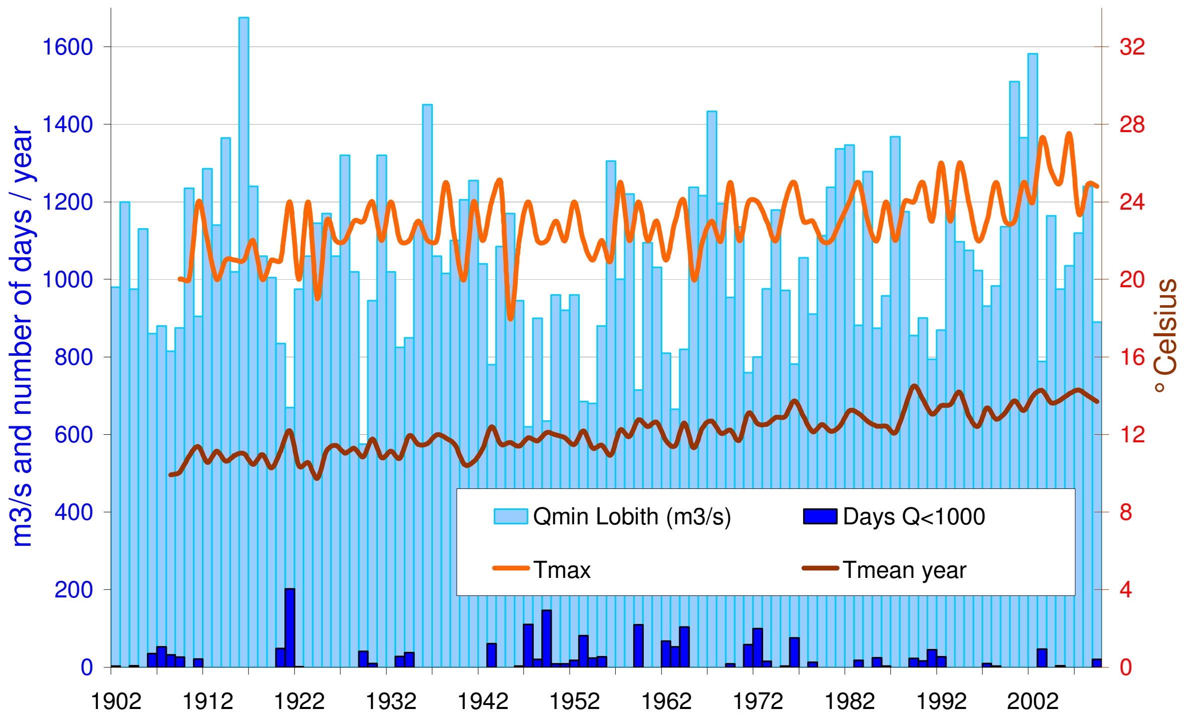

Figure 10: **Mean and maximum water temperatures at Station Lobith**

Groundwater

The groundwater level at Vorarlberg was many times lower than the average. Considered in parts, new lows were recorded in the fall for this time of year.

The groundwater levels and spring flows in the Swiss midlands were at average levels in 2009 due to the widespread average rainfalls. The unusually dry months of August to December led locally to low groundwater levels and spring flows.

Course and Qualities of the Concentrations of Suspended Matter in Switzerland in the year 2009

In the year 2009 the median concentrations of suspended matter at almost all stations were the same as or less than that of the last decade. Only the station Thur-Halden showed a slightly higher level. The estimated annual load is at almost every station smaller or near the average load of the last ten years.

In Emme-Wiler and Little Emme-Littau (Littau measurements began with the measurements in 2004), a new minimum was observed. The annual load at Rhone-Port di Scex, Rhine-Diepoldsau and Thur-Halden were about half the average load. The loads of Little Emme-Littau, Emme-Wiler and Ticino-Bellinzona are between 10% and 25% of the average load of the last ten years (Littau six years). The station of Aare-Brienzwiler, on the other hand, showed a higher annual load for 2009.

2. Activities of the International Commission for the Hydrology of the Rhine Basin (CHR) in the Year 2009

The CHR convened twice in 2009, on May 13-14 in Antony (France) and on October 15-16 in Luxembourg.

Changes within the CHR

At the beginning of 2009, Mr. Hanspeter Hodel was named as the official Swiss representative to the CHR. Mr. Hodel was already active in various CHR projects in years past.

Activities in the CHR Projects

Changes in the discharge regime

The final report of this study was published in 2008. In the past year a detailed summary and a flyer were prepared. The summary is nearly finished and will appear as a PDF in two languages (German and English) on the CHR website in 2010. For the flyer also, we will strive to make 2010 the year of publication. The flyer will be printed (likewise in two languages).

RhineBlick2050

In this project, balanced climate and drainage projections for the international Rhine drainage basin for the year 2050 will be developed.

The objectives and the first results were presented at the Congress of the Central Commission for Rhine Navigation in June 2009.
The final design report was received in December 2009.

HYMOG

In the first phase of this project, consistent data sets will be established for the Rhine from Lake Constance to Lobith. These data should lead to an improvement of the data foundations for hydrologic and hydraulic models for the Rhine basin. The improvements to the models will be undertaken in the second phase. The first phase was awarded to the consultant ProAqua and has begun with a meeting of the steering committee.

Report on Snow and Glacier Melt to the Rhines

A project has been suggested to determine the future contribution of snow and ice melt to the Rhine discharges. A data investigation was contracted to BfG. Further steps will be decided in 2010.

Sediment

The ISI Rhine Case Study with contributions from Switzerland, Germany, and the Netherlands was completed in 2009 and was published as CHR Report II-20.