Hydrological conditions and drought in Swiss groundwaters

Schürch Marc & Kozel Ronald

Federal Office for the Environment FOEN, Swiss Hydrological Survey, Hydrogeology Section, Berne, Switzerland

SWISS GROUNDWATER RESOURCES

83 percent of Swiss drinking water requirements are met by groundwater. About 40 percent of these groundwater resources are provided by the very productive gravel deposits in the wide river valleys which represent some 6 percent of Switzerland’s land surface. These gravel deposits are predominantly fed by infiltrating river water and are well protected against contamination. Carbonate rocks with significant subsurface drainage systems (about 16 percent of the Swiss land surface) provide about 20 percent of drinking water. These carbonate rocks are highly vulnerable to all types of contamination. Molasse sandstones, conglomerates, crystalline rocks and flysch make up 78 percent of the Swiss land surface and provide some 20 percent of drinking water. In these regions, groundwater extraction is limited to small but locally significant springs.

PRECIPITATION AND GROUNDWATER CONDITIONS FOR THE PERIOD 2003-2006

In Switzerland, annual precipitation ranges from 600 to 2000 mm. The period between January 2003 and February 2006 was drier than the long-term mean, especially in the western, south western and south eastern parts of the country. In 2004 and 2005, however, the Plateau and the Alps still received the long-term mean precipitation. In the first six months of 2006 the southern side of the Alps generally received less than 50 percent of the long-term mean precipitation. Between March and May of the same year, precipitation on the northern side of the Alps was some 200% of the long-term mean. July 2006 was extremely hot and dry.

For the period 2003-2005, the discharge of Swiss rivers was consequently lower than the long-term mean. In particular the discharge of the rivers on the Plateau, which is provided by exfiltrating groundwater, was low in summer 2003. In contrast, alpine rivers benefited from high temperatures and accompanying glacier melt-water and as a result showed high discharge in summer 2003 and July 2006.

Groundwater in the gravel deposits of river valleys is normally in close hydraulic connection with the river. As a result, groundwater in the alpine river valleys benefits from the high recharge of infiltrating melt-water during drought periods in summer. In contrast, the groundwater levels in the gravel deposits of river valleys on the Plateau decrease in summer with decreasing river discharge (BUWAL et al., 2004). Because of the precipitation deficits and groundwater recharge deficits in Cantons Valais, Grisons and Ticino for the period 2003-2006, the groundwater levels were below the long-term mean in the Rhone Valley, Rhine Valley (for example Maienfeld, see Figure 1) and Agno Valley (for example Lamone, see Figure 2).

Aquifers in karstified carbonate rocks and near-surface aquifers in unconsolidated rocks with small recharge areas react rapidly and sensitively to changing meteorological conditions. As a result, the groundwater levels and spring discharge decreased significantly in these areas during the drought of 2003, and several springs ran dry. The aquifers in karstified rocks with large recharge areas and aquifers in fractured rocks reacted more slowly to the drought of 2003; in these areas spring discharge was still respectable after the long drought of 2003.

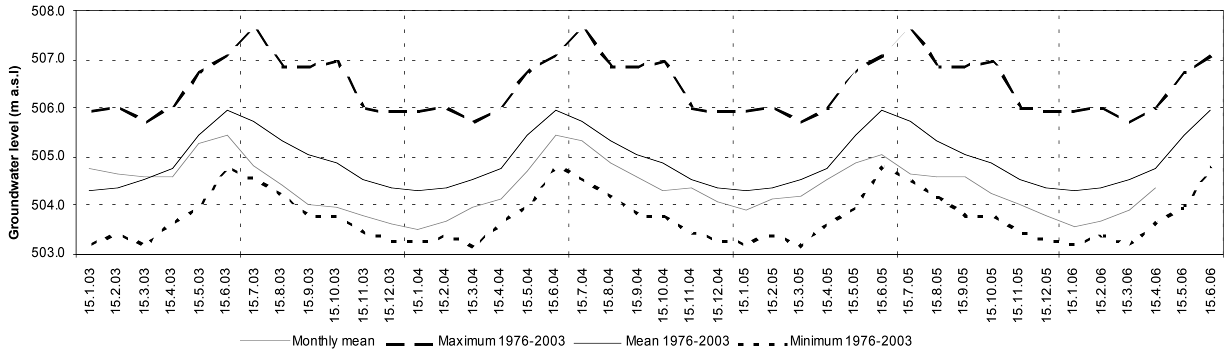

Figure 1: Monthly mean groundwater level for the period between January 2003 and June 2006 at Maienfeld, Rhine Valley, Canton Grisons.

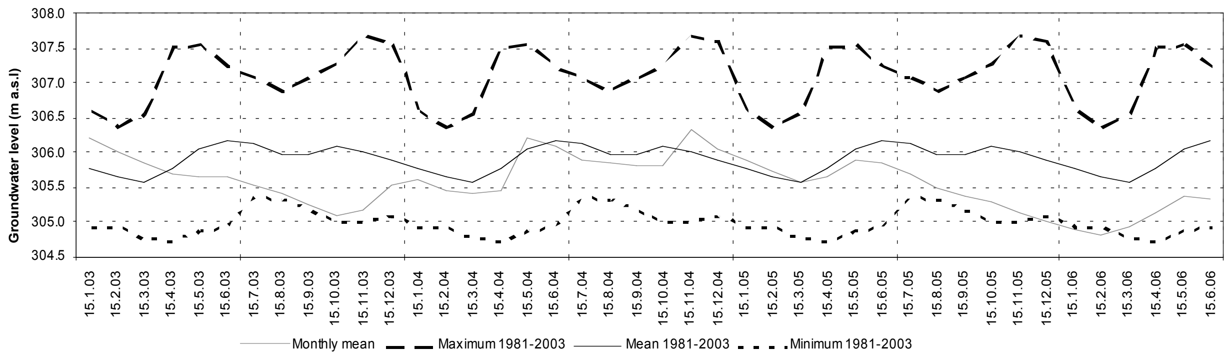

Figure 2: Monthly mean groundwater level for the period between January 2003 and June 2006 at Lamone, Agno Valley, Canton Ticino, southern side of the Alps.

THE IMPACT OF MORE FREQUENT DROUGHT PERIODS ON GROUNDWATER

Common climate scenarios predict that hot, dry summers and hydrological droughts such as that in 2003 will correspond to a mean summer in 2100 (ProClim 2005). As a result, the groundwater recharge would decrease in summer, and groundwater use in irrigation is expected to increase. Groundwater levels in river valleys on the Plateau and spring discharge in areas with near-surface aquifers with small recharge areas would decrease significantly. Those springs could run dry in summer and autumn. The more frequent drought periods would have less impact on groundwater levels in the gravel deposits of alpine river valleys provided that melt-water recharges groundwater in these areas. To guarantee drinking water requirements during hydrological drought periods, a diversified approach is needed which takes into account different water sources (springs, pumping wells, lakes). Sustainable long-term groundwater management must be based on a well-developed groundwater monitoring system.

REFERENCES

BUWAL, BWG & MeteoSchweiz (2004): Auswirkungen des Hitzesommers 2003 auf die Gewässer. Schriftenreihe Umwelt Nr. 369, Bern: Bundesamt für Umwelt, Wald und Landschaft.

ProClim (2005): Hitzesommer 2003 – Synthesebericht. Forum for Climate and Global Change, Berne.