2003 - an extremely hot and dry summer in Croatia

After a very dry and relatively warm spring (particularly May), the business community was looking forward to more favourable weather in the forthcoming summer. Unfortunately, a markedly hot and dry summer followed, resulting in great damage to agriculture, river traffic, forestry (forest fires), the electric-power industry, water resources and other areas. This report shall try to present the scale of this prolonged natural disaster.

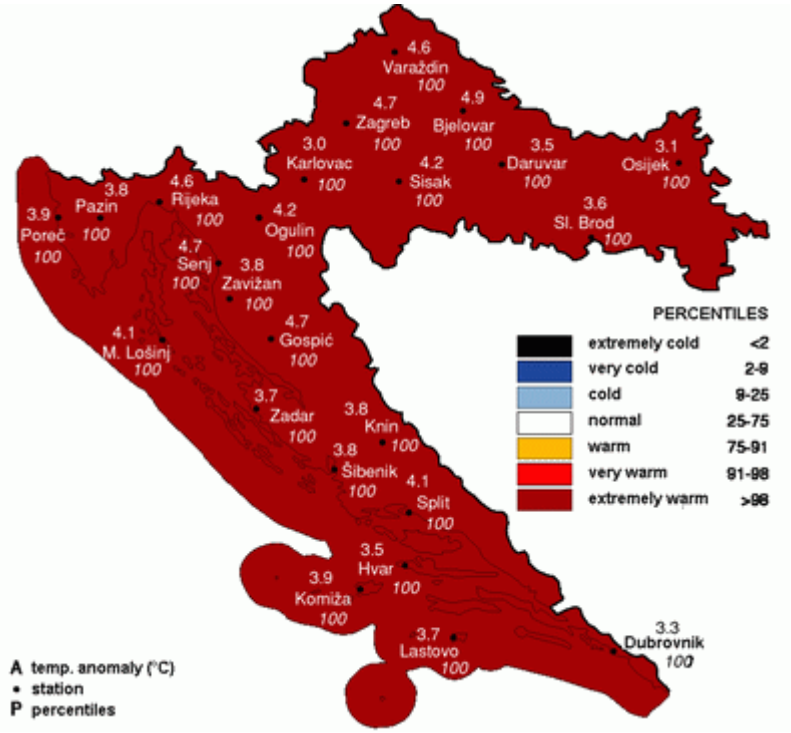


Figure 1. Summer 2003 - the mean seasonal air temperature deviation (°C) from the corresponding average values for the period 1961-1990.

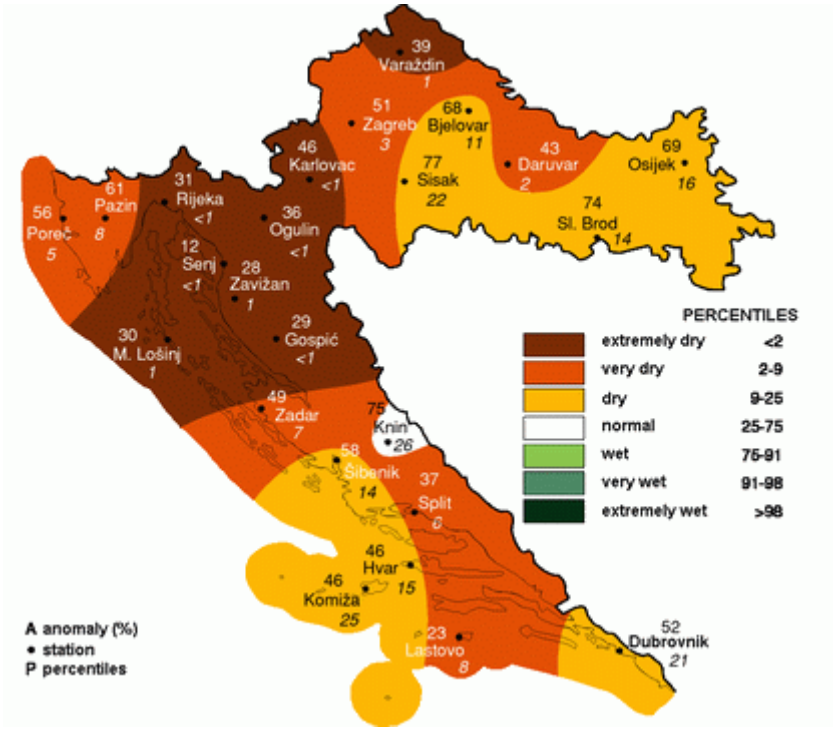
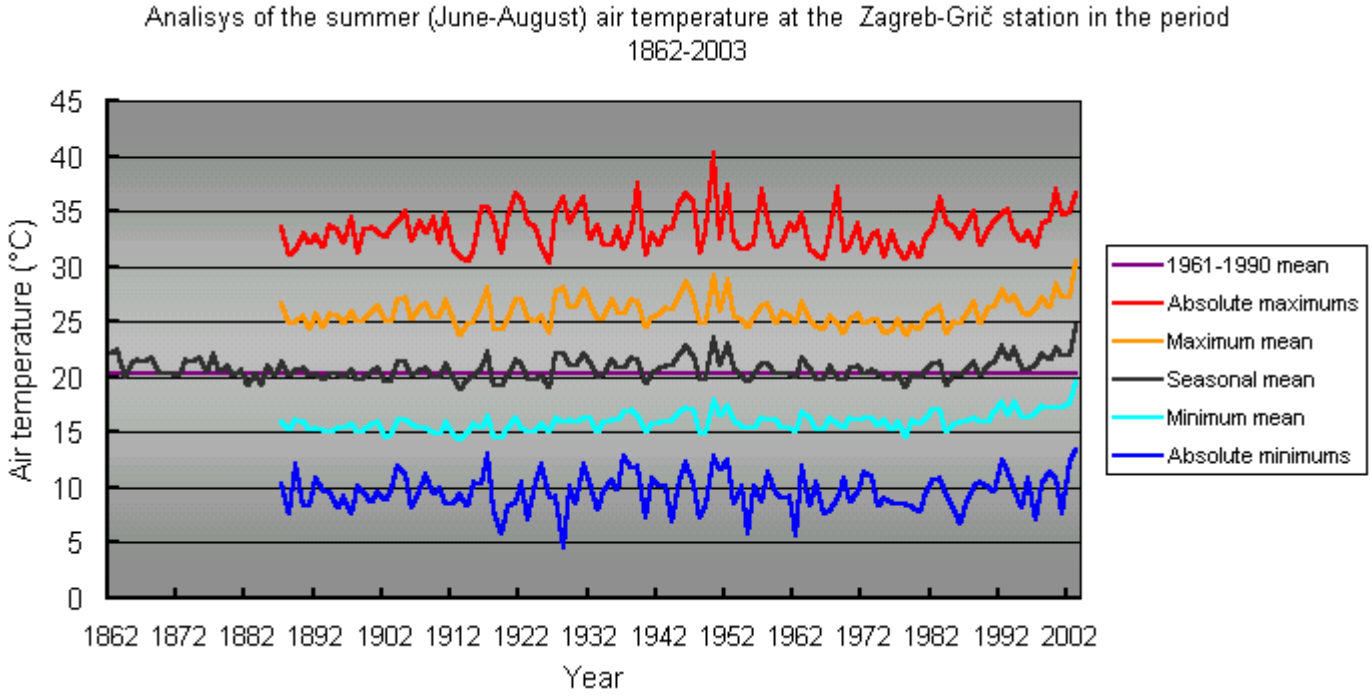
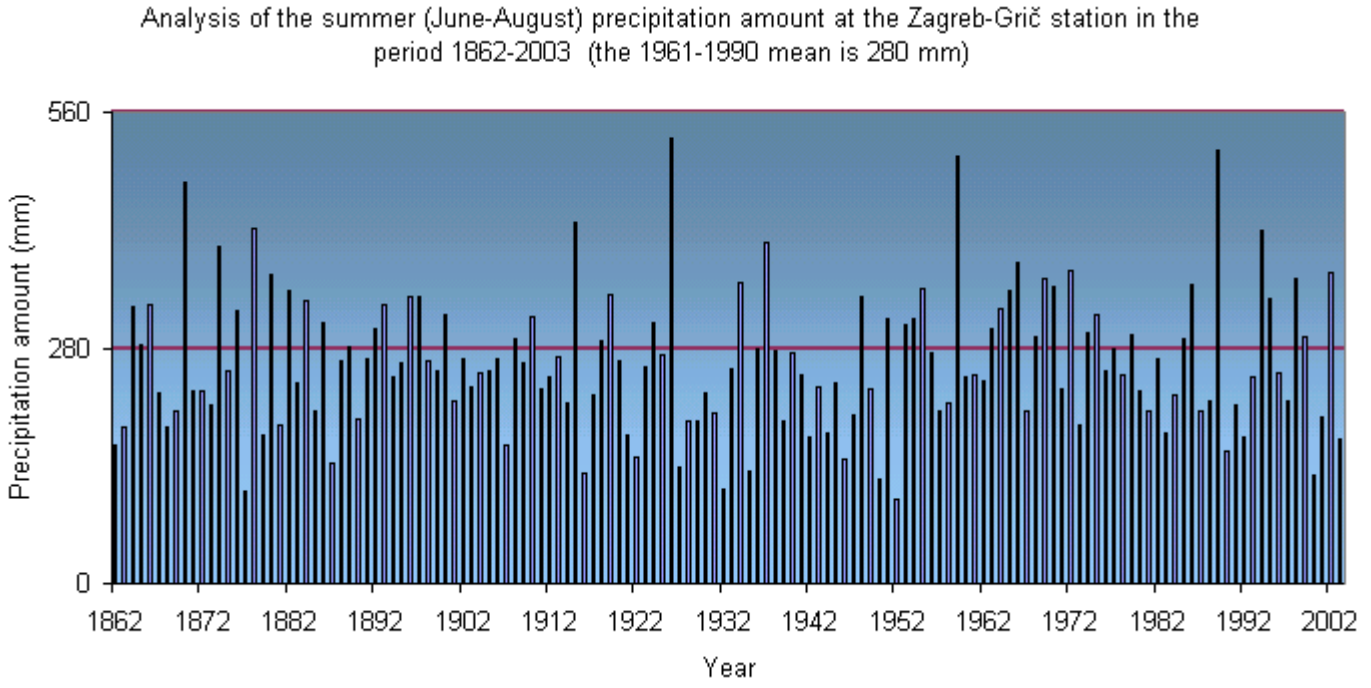


Figure 2. Seasonal precipitation quantities for summer 2003, expressed as percentage of the average values for the period 1961-1990.

A long, hot summer

The data on the map in Figure 1 show that the summer of 2003 (June, July, August) was extremely hot all over Croatia. The average seasonal temperatures exceeded the seasonal mean over several years by 4-5 degrees Centigrade (this mean was 20.4 °C for the period 1961-1990). That this was a significant temperature anomaly (lasting for such a long period) is visible from a comparison with the measurements performed at the Zagreb-Grič station over the last 142 years and presented in the attached graph. It has to be pointed out, though, that the absolute maximum (36.7 °C) did not reach the highest ever temperature (40.3 °C) measured in Zagreb in 1950, during another rather hot summer. However, the mean maximal and minimal temperatures were the highest since the measurements started. It can be stated that both days and nights were uncommonly warm, which resulted in an extremely high mean seasonal temperature. At the same time, a trend has been noticed of summers getting warmer and warmer these last ten years. It is not possible to claim that this warming is part of the global warming, although certain research results seem to suggest this possibility. Namely, atmospheric models show that the atmosphere, as a dynamic-chaotic system, is sensitive to even small external influences, like the one resulting from a growing concentration of greenhouse gases.





Following on the spring drought

The unusually dry spring weather continued into the summer. As shown in Figure 2, dry to extremely dry weather prevailed throughout Croatia, with the exception of Knin. The lack of precipitation was most pronounced in central Croatia, where the precipitation amount reached barely 30% of the 30-year average. However, according to the one-century-long precipitation measurements at Zagreb-Grič (see attached drawing), an even smaller amount of precipitation was measured recently, in 2000, with the smallest amount being recorded in 1950 - only about a hundred millimetres. The same graph shows that over 500 mm were measured in 1926, which is five times the minimal amount. When interpreting this year's drought, time and spatial relations and phenomena have to be considered as well as the thermal conditions which induced increased evaporation.

Lack of precipitation coupled with heat dried out the soil. Thus, already on 5 June 2003, at the Križevci main agrometeorological station, the field moisture capacity of the powdery clay soil was 27 l short at a depth of 10 cm, 77 l at 30 cm and 170 l at 60 cm per square meter. It is also worth mentioning that easily accessible water was insufficient at a depth of 60 cm. This situation continued through July and August, meaning that at a depth of 60 cm the actual soil humidity was lower than the lentocapillary moisture, i.e. at 60 cm there was no available water in the soil. Vine leaves could be seen yellowing. Not only the soil was dry but the soil temperature was extremely high. At a depth of 2 cm, temperature values rose to 36 °C in Krapina, 38 °C in Križevci, 42 °C in Varaždin, 44 °C in Slavonski Brod and up to 45 °C in Osijek. All plants experienced a temperature shock. The maximal air temperature values in eastern and western Croatia exceeded 35 °C. Luckily, the average daily relative air humidity did not exceed 80% so that the conditions for the development of plat diseases were not particularly favourable. These very high maximal air temperatures had a particularly damaging effect on corn, which was in its fertilization period. Corn also suffered from lack of water in the soil. It is known that in dry years, like this one, the vegetation period is considerably shortened. Potatoes yielded a poor crop and had to be dug up earlier than usual. The amount of tomatoes and other vegetables was reduced. On the islands, sheep and goats had not enough food. Lack of moisture in the soil affected also perennial plants with deeper root systems. It was enough to see the colour of deciduous woods, which was neither light nor dark green but rather light brown. It was obvious that there was not enough accessible water even in the deeper layers of soil. On 31 August, farming crops looked as they usually do at the end of September. The harvest of early varieties of grapes had to start. Apples and plums started falling to the ground. Seedbed preparation for autumn started but the soil was so dry that its setting was hard and of poor quality. The water temperature in fish farms rose so much that most of the fish died off.

This long period without precipitation brought about hydrological drought. According to some authors, hydrological drought or low-level water period refers to a period during which the flow in open streams is smaller than the amount required by its users. However, most hydrologists define hydrological drought as a water volume deficit (low-level waters) below a certain reference discharge, taking into account the length of the dry period. For example, this year's hydrological drought of the Sava River at Županja started on 26 June and is still continuing - well over 70 days. Taking into consideration its intensity and duration, according to hydrological criteria, this year's hydrological drought is one of the most pronounced in the last 59 years. More severe droughts were registered only in 1946, 1947 and 1950. It may be said that such an intensive hydrological drought has not occurred for over 50 years. It can be also mentioned that extremely dry periods were registered in 1946-1950, 1990-1993 and in 1971 and 2000. Low-level waters appear in Croatia mostly in autumn and spring (and in the Drava catchment in winter) and they are practically non-existent in spring. These facts can help with the planning of water resources.

Finally, it has to be mentioned that damage from drought is eight times greater than damage from floods (period processed: 1980-2000). The National Meteorological and Hydrological Institute, depending on its financial and human resources, invests daily in the future through weather, climate and water observations. According to WMO research, one Euro invested in meteorology and hydrology brings 10 Euro benefit.