



# Impacts of Summer 2003 Heat Wave in Europe

The extreme drought and heat wave that hit Europe in the summer of 2003 had enormous adverse social, economic and environmental effects, such as the death of thousands of vulnerable elderly people, the destruction of large areas of forests by fire, and effects on water ecosystems and glaciers. It caused power cuts and transport restrictions and a decreased agricultural production. The losses are estimated to exceed 13 billion euros.

## Issue and Causes

The severe heat wave began in Europe in June 2003 and continued through July until mid-August, raising summer temperatures 20 to 30% higher than the seasonal average in Celsius degrees over a large portion of the continent, extending from northern Spain to the Czech Republic and from Germany to Italy (see map below).

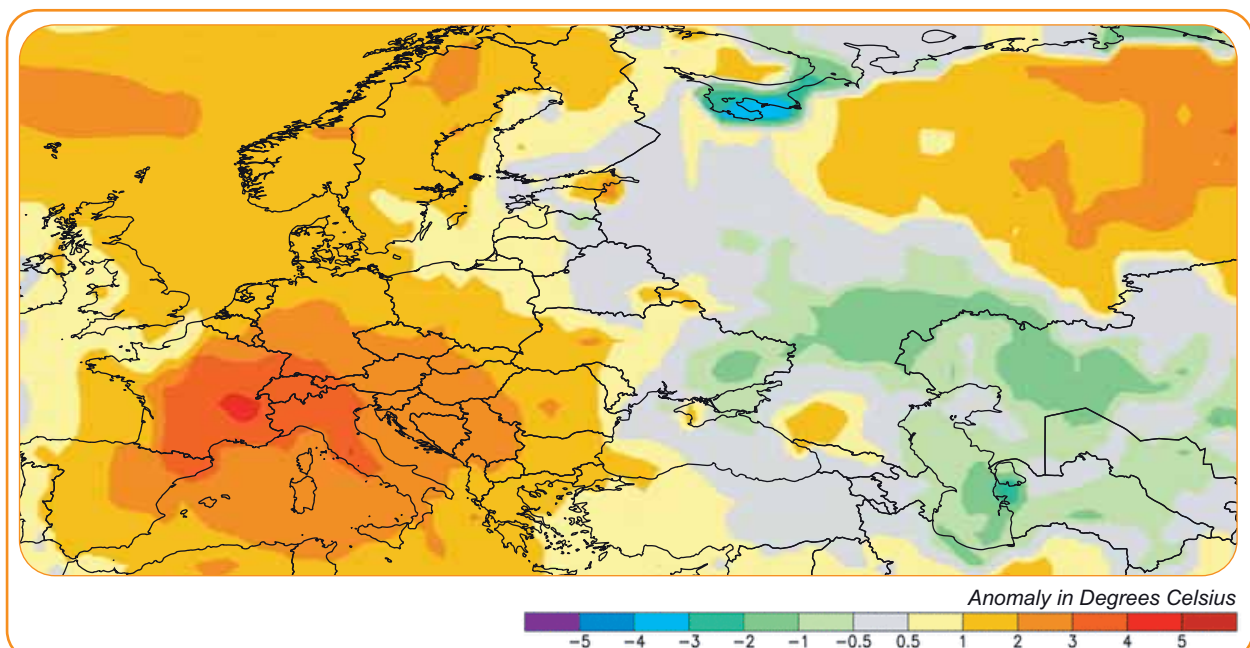
Extreme maximum temperatures of 35 to 40°C were repeatedly recorded in July and to a larger extent in August in most of the southern, and central countries from Germany to Turkey. This extreme weather was caused by an anti-cyclone firmly anchored over the western European land mass holding back the rain-bearing depressions that usually enter the continent from the Atlantic ocean. This situation was exceptional in the extended length of time (over 20 days) during which it conveyed very hot dry air up from south of the Mediterranean.

The all-time maximum temperature recorded in the United Kingdom was broken on 10 August, with 38.1°C; temperatures in France soared to 40 °C and remained

unusually high for two weeks. In Switzerland, June was the hottest month ever recorded in 250 years of archives and a temperature record of 41.5 °C was reached on August 11. With temperatures exceeding the average by +5.4°C in Geneva, the prevailing conditions corresponded to a usual summer in Rio de Janeiro! July was characterised by dry conditions centred on France, Spain, Germany and Italy.

This hot and dry spell extended to Central Europe in August. The low precipitation during this period failed to compensate for the accumulated evapotranspiration of almost 400 mm in the Mediterranean area, creating an accumulative water balance deficit of up to 380 mm in South Europe and of 200 mm over most of France, Germany, western Czech Republic, Hungary and southern Romania.

*NDC/NOAA, EUROPEAN COMMISSION - JRC, March Bulletin 20, MeteoSwiss, Meteorological Bulletins, June, July, August, September 2003.*



*This map, produced from both in situ and satellite information (NDC/NOAA), shows the extreme deviation from the average as recorded from June to August 2003. In some areas the difference exceeds 4°C. Climatological base period is 1988-2003.*



## Consequences

### Highest death toll from natural hazards in 50 years

With a death toll estimated to exceed 30 000, the heat wave of 2003 is one of the ten deadliest natural disasters in Europe for the last 100 years and the worst in the last 50 years. Elderly people were most affected.

France reported 14 802 casualties using a method from the National Institute of Health and Medical Research (INSERM, France). This figure was reached by counting the number of deaths over and above what would normally be expected for the month of August. Italy followed the same formula and counted more than 4'000 elderly casualties during the month of August in Italy's 21 largest cities.

Country	Casualties
France	14 082
Germany	7 000
Spain	4 200
Italy	4 000
UK	2 045
Netherlands	1 400
Portugal	1 300
Belgium	150

INSERM: "Sumortalité liée à la canicule de l'été 2003", AP September 25, 2003

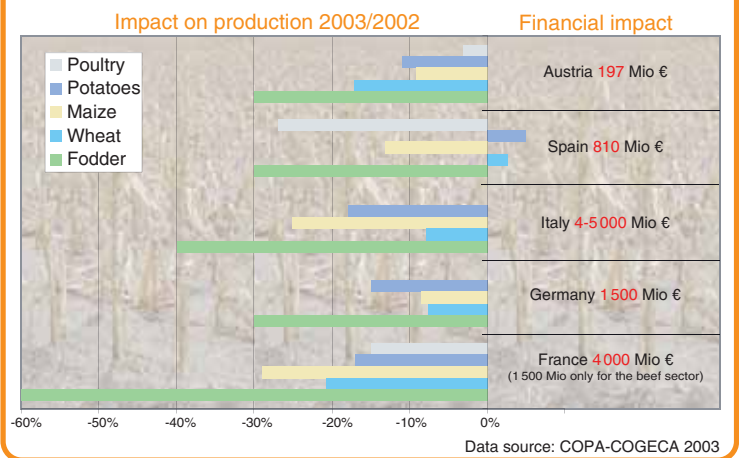
### Agriculture and forestry production impacted

This year's extreme weather conditions decreased the quantity and quality of the harvests, particularly in Central and Southern European agricultural areas; threatening a large proportion of harvests, and increasing production costs.

The winter crops already suffered from the effects of a harsh winter and late spring frost. The heat wave that began in early June accelerated crop development by 10 to 20 days, thus advancing ripening and maturity. Winter-spring cereals formed grain with insufficient soil moisture. The very high air temperature and solar radiation, especially from the second part of July to the beginning of August, resulted in a notable increase in the crops' water consumption. This, together with the summer dry spell, resulted in an acute depletion of soil water and lowered crop yields. Even in Switzerland, the "water tower" of Europe, river withdrawals for agricultural use were banned in some cantons from July to mid October, thus affecting producers of potatoes and tobacco. According to the Union of Swiss Farmers, the agricultural deficit reached more than 300 millions CHF (~US\$ 230).

Over all of Europe, the main sectors hit by the extreme climate conditions were the green fodder supply, the arable sector, the livestock sector and forestry. Potato and wine production were also seriously affected. The fodder deficit varied from 30% ( Germany, Austria and Spain) to 40% (Italy) and 60% in France. In Switzerland, fodder had to be imported from as far away as Ukraine. The fall in cereal production in EU reached more than 23 million tonnes (MT) as compared to 2002. This low cereal harvest will have to be topped up by

### Impact of the summer 2003 heat wave and drought on agriculture and forestry in 5 selected countries



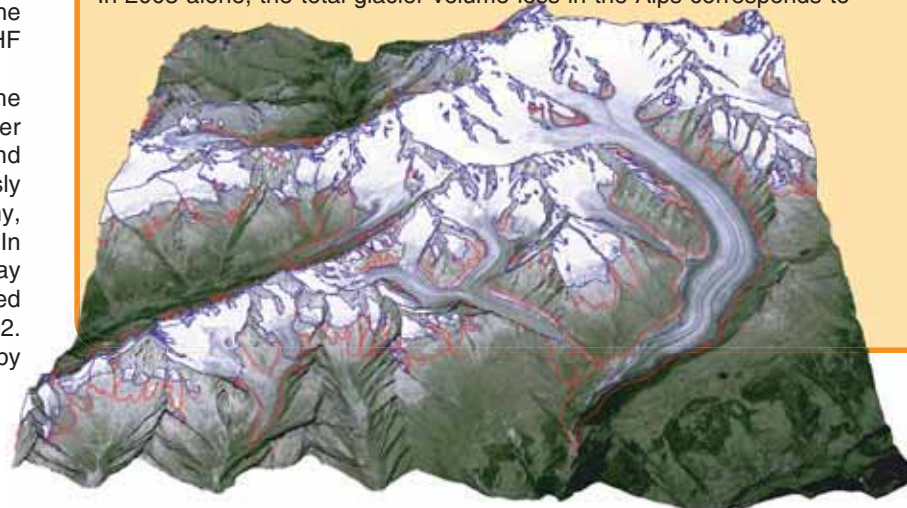
more than 6 MT of imports under the mandatory quotas and more than 10 million tonnes available from carry-over stocks. The livestock farmers suffered the most, and will suffer even more in the coming winter due to lack of green fodder and the possible increase of compound feed prices resulting from the reduction in herd sizes. Additional side effects will be felt in the coming months such as problems of soil erosion and flooding, effects on winter sowing, and the budding of trees.

COPA COGECA 2003: Assessment of the impact of the heat wave and drought of the summer 2003 on agriculture and forestry.

### "Mass of Alpine glaciers decreased by up to 10% in 2003"

According to Professor Wilfried Haeberli, director of the World Glacier Monitoring Service (WGMS) at the Geography Department, University of Zurich, first results from field measurements indicate that the extreme warm and dry weather conditions in summer 2003 caused an average loss in thickness of glaciers in the European Alps of about 3 meters water equivalent (see graph on the right), nearly twice as much as during the previous record year of 1998 (1.6 m), and roughly five times more than the average loss of 0.65 m per year recorded during the exceptionally warm period 1980 - 2000.

The World Glacier Monitoring Service follows the evolution of annual glacier mass balance (thickness change) through the monitoring of more than 60 reference glaciers worldwide and 14 glaciers in the Alps. In 2003 alone, the total glacier volume loss in the Alps corresponds to



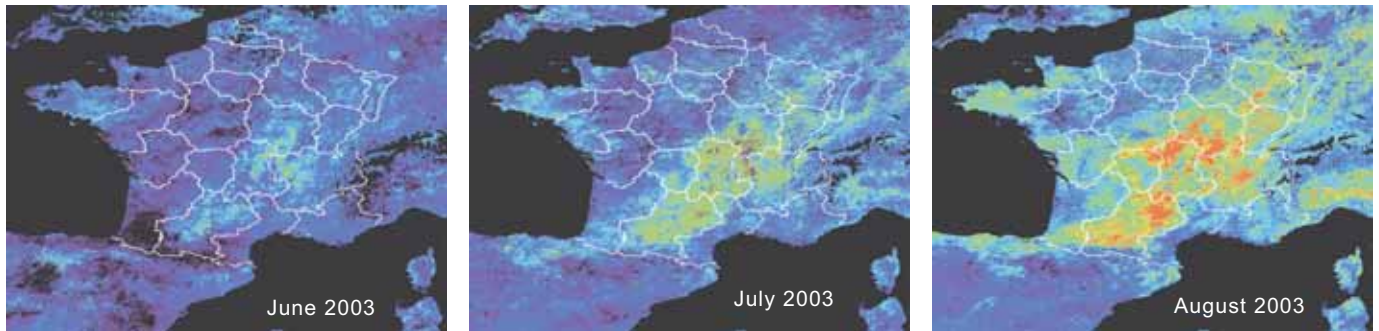
**The impact of drought on vegetation**

Drought affects the state of vegetation by lowering photosynthetic activity leading to a reduction in productivity, in particular for crops and fodder. It also affects forests, weakening trees and making them more vulnerable to diseases and insect attacks.

Another consequence of the heat wave was to force the early harvest of crops that became mature much earlier than usual. In addition, some types of vegetation were killed by the extreme

conditions of drought and temperatures bordering on 40°C. Water stress also encourages forest fires, which were particularly intense with the exceptional climatic conditions of the summer of 2003.

*CNS September 23, 2003: Communiqué de presse.*



The effects of the drought on vegetation are clearly visible. The images represent the variation of the vegetation index in the summer of 2003 compared to the summer of 2002. The blue zones on the map represent a vegetation condition in 2003 similar to that in 2002. Spain appears in blue as 2003 was as dry as 2002. The green, yellow red, areas were drier than in 2002. Above all drought affected the South Western part of France, the Central Massifs and the Northern part of Italy. This caused the yellowing or early fall of leaves, early harvesting, forest fires.

copyright CNES 2003, distribution Spot Image  
 Similar to 2002      Drier than 2002

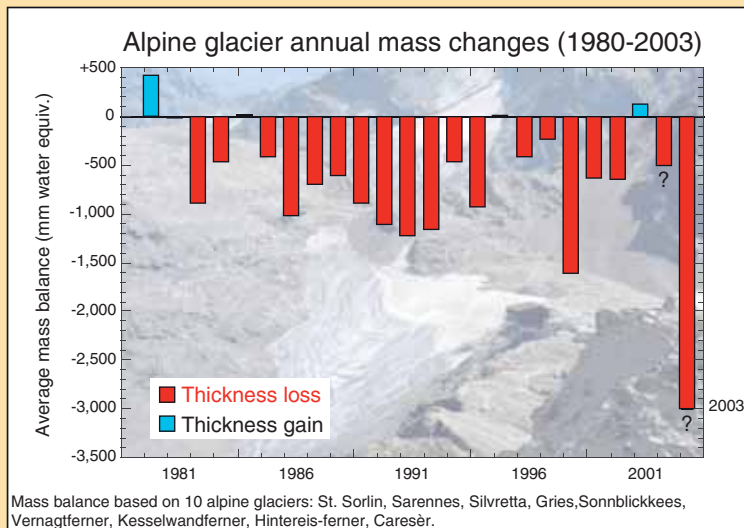
**Energy**

The heat wave spelled trouble for France's nuclear reactors, many of which are cooled by river water. The plants return cooling water to the rivers, but only after it has cooled down to reduce the impact on the environment. In some regions, river water levels dropped so low that cooling process became impossible and plants had to shut

down, while elsewhere the water temperatures after the cooling process exceeded environmental safety levels. An exceptional exemption from the legal requirements was granted to six nuclear reactors and a number of conventional power stations: The nuclear power plants of Saint-Alban (Isère), Golfech (Tarn-et-Garonne), Cruas (Ardèche), Nogent-sur-Seine (Aube), Tricastin (Drôme) et Bugey (Ain) continued functioning, although the upper legal limits were exceeded.

Moreover, demand for electricity soared as the population turned up air conditioning and refrigerators, but nuclear power stations, which generate around 75% of France's electricity, operated at a much reduced capacity. In order to conserve energy for the nation, France (Europe's main electricity exporter) cut its power exports by more than half.

*"The Guardian" August 13, 2003, "Le Monde" August 13, 2003  
 EDF Note d'information August 29, 2003*



Mass balance based on 10 alpine glaciers: St. Sorlin, Sarennes, Silvretta, Gries, Sonnblickkees, Vernagtferner, Kesselwandferner, Hintereis-ferner, Caresèr.  
 Courtesy: Regula Frauenfelder (World Glacier Monitoring Service, Zürich)

5-10% (probably closer to 10%) of the remaining ice volume. Alpine glaciers had already lost more than 25% of their volume in the 25 years before 2003, and roughly two-thirds of their original volume since 1850 (see figure to left). At such rates, less than 50% of the glacier volume still present in 1970/80 would remain in 2025 and only about 5% in 2100."

**Permafrost changes affect long-term rock stability**

The 0°C limit rose above 4500 meters elevation for 10 days. This unusual duration increased impacts, especially on shady rock walls at high altitudes, where thaw penetrated considerably deeper than in previous (warm) years and some areas may have been exposed to thawing for the first time. Numerical simulations by the Glaciology and Geomorphodynamics Group at the University of Zurich confirmed measurements of borehole temperatures in a network of the European Alps, showed that thaw penetration below the surface was up to 2 meters deeper than in previous years. These extreme conditions caused widespread but relatively small rockfalls, such as the one which forced the evacuation of 90 persons on the Matterhorn. However, deep penetration of permafrost warming and thawing over longer time periods (decades, centuries) might cause larger landslides and rock falls at high altitudes.

Left: This 3D view of the Aletsch region with a satellite image from 1997, depicts glacier extent of 1850 (in red), 1973 (in blue). The Aletsch glacier is now formally a part of the UNESCO World Heritage Programme.

Sources: Geography Department, University of Zurich, DEM25 (C) 2003 swisstopo.



## Forest Fires in Portugal on 3 August 2003

Red polygons show active fires as detected by the MODIS sensor on the Aqua satellite. The north of Portugal is hidden by a large cloud of smoke. Image courtesy Jacques Descloitres, MODIS Rapid Response Team at NASA GSFC.

## Nearly 650'000 ha of forest burned

Due to a combination of the abnormal temperatures which occurred in July and August and criminal acts, major forest fires received significant media exposure during the summer.

More than 25 000 fires were recorded in Portugal, Spain, Italy, France, Austria, Finland, Denmark and Ireland. The estimation of forest areas destroyed reached 647 069 hectares. Portugal was the worst hit with 390 146 ha burned, destroying around 5.6 % of its forest area. Spain came second with 127 525 ha burned. The agricultural area burned reached 44 123 ha plus 8,973 ha of unoccupied land, and 1 700 ha of inhabited areas. This was by far the worst forest fire season that Portugal had faced in the last 23 years. In October 2003, the financial impact estimated by Portugal exceeded 1 billion euros.

*COPA COGECA 2003: Assessment of the impact of the heat wave and drought of the summer 2003 on agriculture and forestry.*

*EU-JRC 2003: The European Forest Fires Information System (EFFIS) results on the 2003 fire season in Portugal to the 20th of August.*

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The global financial impact of the drought and the forest fires over most of Europe exceed 13 billion €.

(COPA COGECA 2003)

## Perspectives

### European heat wave and global warming: extremes increasing

The record high temperatures in the summer of 2003, and repetitive temperature records, raise the problem of global warming impacts on human activities and ecosystems.

Global warming is a fact proven by the scientific community. According to the last IPCC<sup>1</sup> assessment report, the global average surface temperature has increased over the 20th century by about 0.6 °C. This value is about 0.15°C higher than that estimated by the previous reports. Data for the Northern Hemisphere indicate that the increase in temperature in the 20th century is likely to have been the largest and fastest in any century during the past 1000 years.

New record extreme events occur every year somewhere on the globe, but in recent years the number of such extremes has been increasing (WHO Press release). We cannot directly attribute this one event to climate change, but this type of occurrence is expected to happen more frequently. The heat wave that hit Europe in the summer of 2003 can be seen as one more warning of impacts from a warmer climate on populations and ecosystem. ♦

<sup>(1)</sup> IPCC: Intergovernmental Panel on Climate Change; "Third Assessment Report"  
WHO: Press release No 695

**"As the global temperatures continue to warm due to climate change, the number and intensity of extreme events might increase"**

(World Meteorological Organisation)

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March 2004