GWES in case of floods
with respect to the flood on the Labe (Elbe) River
in the Czech Republic in August 2002

Jan Šilar

Charles University, Prague, Czech Republic
Floods in the East of the Czech Republic in summer 1997 and 1998 caused serious problems in the public water supply.

A similar situation repeated in August when a flood of a 500 years recurrence interval inundated the valleys of the Vltava and Labe Rivers and affected groundwater resources in their alluvial plains.
České Kopisty village in the flood plain area of the Elbe River
The Labe River is the main stream in Bohemia (the western part of the Czech Republic): a drainage area of 51,000 km\(^2\) is almost identical with historical Bohemia.

The **mean and minimum discharges** of Labe are **293 m\(^3\)·s\(^{-1}\)** and **58 m\(^3\)·s\(^{-1}\)**, respectively.

In **August 2002**, the discharge of the Labe in Ústí nad Labem, the district capital in northern Bohemia and a river port, reached **5100 m\(^3\)·s\(^{-1}\)**.
Movement of two successive significant pressure lows within a short time period brought extreme floods in Central Europe. Both moved very slowly, causing prolongation of the period of persistent precipitation.

During the first precipitation event on 6 and 7 August 2002, the total volume of the precipitation was 2.4 km$^3$ (Fig. 1.1) while during the second event in the period from 11 to 13 August 2002 it was 6.7 km$^3$ (Fig. 1.2).

Fig. 1.3 shows the spatial distribution of total precipitation in the period from 6 to 16 August.
The main reason of the extraordinary high flood: the meteorological situation:
Figure 1.1 Map of precipitation in the period from 6th to 7th August 2002

Figure 1.2 Map of precipitation in the period from 11th to 13th August 2002

Figure 1.3 Map of precipitation in the period from 6th to 15th August 2002
The highest 10-day precipitation totals exceeding 400 mm occurred in southern Bohemia at the border with Austria and in North-West at the border with Germany.

The **total volume of precipitation** from 6 to 15 August 2002 on the territory of the Czech Republic amounted **almost 9.7 km$^3$**. In August 2002, the mean area precipitation on the territory of the Czech Republic was at the level of **225 % of long-term mean**. In South Bohemia, it was even **381 % of the mean**.
Figure 3.4  Flood hydrographs of the Vltava and Elbe Rivers
THE AIM of the investigation was to test the application of isotope-hydrology techniques, namely groundwater dating, in the investigation of emergency groundwater resources in the geological setting of the Czech Republic.

METHODS USED
To follow the residence time and vulnerability of ground water, radiocarbon dating was used. A long residence time of groundwater may indicate a low degree of groundwater vulnerability. The longest residence times may be expected in the basin structures.
GEOLOGY
of the
CZECH REPUBLIC
The investigated area is indicated by a rectangle at upper left. Groundwater containing carbon dioxide of magmatic origin was excluded from the evaluation. The results were compared by means of histograms. Samples from the deep Cretaceous aquifers in the lower reaches of the Labe River are specific by a high radiocarbon age. Seventy-five percent of the groundwater samples from deep wells show a Pleistocene age, 25 % are Holocene. Groundwater of modern age was not found in any of the deep wells.
Figure 1. Histograms of radiocarbon ages
approximate frequency (samples/year)

radiocarbon age of water samples (years B.P.)

total number of samples: ..................22
number of modern samples .................1
average radiocarbon age
  (without the modern sample) ..........14165 years
median radiocarbon age
  (without the modern sample) ..........16090 years
Safe groundwater resources with a long residence time can be expected primarily in the deep confined Cretaceous aquifers.

The groundwater in unconfined aquifers is prone to contamination.

It is vulnerable not only by floods but also due to human activities in the industrial region of northern Bohemia.
Chemical Factory Spolana Neratovice on the Elbe River bank was flooded by the backwater from the Vltava River.
Conclusions:
It has been found that within the Bohemian Massif, aquifers with the longest groundwater residence time and with protected groundwater resources can be found in the inner and deeper parts of the basins in the platform cover. This refers also to the region along the lower reaches of the Labe (Elbe) River, which was seriously affected by the flood in 2002.

In the areas of Ústí nad Labem and Děčín, the confined water has a positive pressure above the surface and a temperature between 30°C and 36°C. This groundwater is resistant to pollution from the surface and can be used in case of damage of the public water supply systems, which use conventional shallow groundwater resources.