Causes and Consequences of a Flood Wave on the Lower Reach of the Dyje River Near Břeclav

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Abstract: The settlements situated on broad flat floodplains of rivers are threatened by floods during increased water flows in the rivers. The floodplain of the Dyje river situated in the area between the Nové Mlýny water reservoir and Břeclav has been protected from former annual floods since the 70s of the last century due to the water-management measures. The realised measures including the construction of the new floodway protect the town of Břeclav as well. A long-term research into the soil water regime of the floodplain forest is underway in the region. The results obtained document its historical evolution and current status. Only in the early April of 2006 (i.e. after 34 years), an unexpected "flash flood" occurred again due to a specific climatic situation. The combination of the high snow cover in higher parts of the basin and a rapid warming up caused an intensive runoff. The so-called dry polder (floodplain forests, meadows and fields) above Břeclav protected the town and its infrastructure from potential catastrophic consequences.

Keywords: basin; climatic characteristics; dry polder; floodplain forest; floods; sewerage; soil water regime

Urban agglomerations including the costly infrastructures situated in the broad floodplain valleys of rivers are often threatened by increased water flows. Thus, they have to be protected against the floods. The influence of human activities consisting of the river flow regulations is evident not only in the urban areas but it also significantly affects the surroundings – mostly the cultural landscape. This fact is widely described and quoted not only in Czech but also in foreign literature (Klimek 1987; Décams *et al.* 1988; Penka *et al.* 1991; Gregory *et al.* 1992; Dynesius & Nilsson 1994; Štěrba 1994; Lajczak 1995; Bravard & Petts 1996; Prax & Hadaš 1998; Demek 1999; Prpič 2005 and others). The modelling of natural water retention in the catchement basin during flood is presented in Palát *et al.* (2008).

The Dyje river used to be a threat to the town of Břeclav during its increased spring flows. For example, spring floods in 1941 had catastrophic consequences (Figure 1).

The data of the National Water Management Plan of the Czechoslovak Republic of 1954 show that the Dyje river culminated on March 12th 1941, when the flow rate at the Dolní Věstonice station was 820 m^3/s. It was a historical analogy to the situation which occurred in 2006 (described below). The upper basin of the Dyje river was covered with about 70 cm thick layer of snow. Rain came down on March 10th and 11th. Midday temperatures reached 9°C and did not drop below the freezing point at nights.

The water-management measures on the Dyje river including a new floodway of the river around Břeclav in the 70s protected the area against floods. These above mentioned measures on of the Dyje river also protect the floodplain forests and meadows in the broad floodplain of the dyked stream.

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Figure 1. Břeclav – flood in 1941

Previous regular inundations were wound up after 1972, i.e. after the realised water management measures (Penka *et al.* 1991).

The region was hit again by a short and rather unexpected flash flood in 2006 after 34 years. Untypically, this was not directly connected with the actual slightly increased precipitation in the region (Hadaš 2006; Vašků 2009).

MATERIALS AND METHODS

The territory affected by flash floods in the spring of 2006 lies in the floodplain of the Dyje river which runs through the town of Břeclav. Floodplain forests, meadows, and fields north of the urban area were inundated. For the documentation of this event were used the climatic and hydrological data measured in CHMI Brno as well as the results obtained during a long-term research into the floodplain forests and meadows moisture regime by the Institute of Forest Ecology of the FFWT, Mendel University in Brno. Namely the data of the climatic, precipitation and hydrological stations at Lednice na Moravě, Kostelní Myslová, Stonařov, Svratouch, Ladná, Veverská Bítýška, Znojmo, Bílovice, coming from the incriminated period, were used for the evaluation.

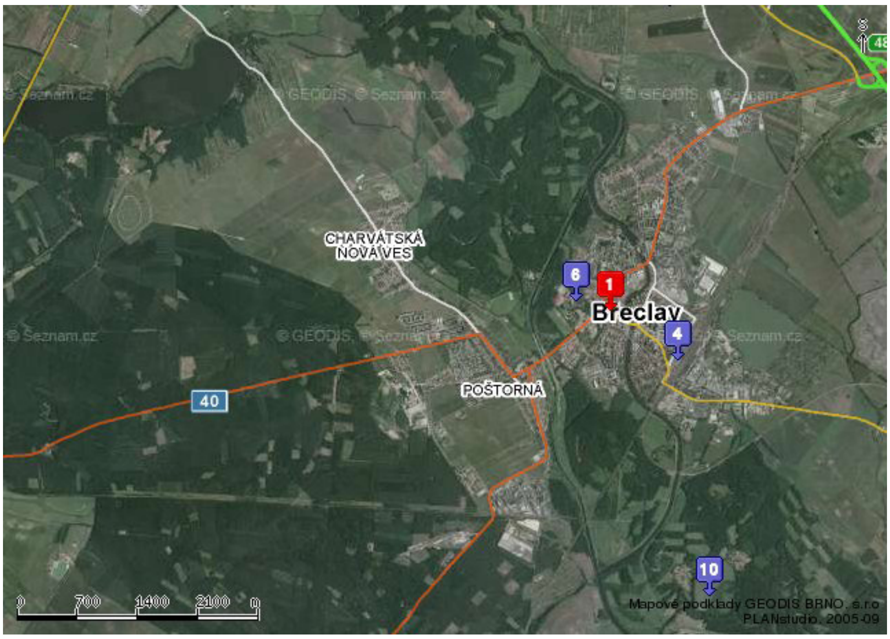

Figure 2. The view of Břeclav and surroundings including the floodway of the Dyje river

Figure 3. Flooded forest in the Horní les locality – Lednice na Moravě in late March and early April 2006 (photo by L. Rygl)

The results of the floodplain soil moisture regime monitoring including the dynamics of the underground water level were obtained on a stationary research object of the Institute of Forest Ecology in Lednice na Moravě – Horní les locality. The information collected by the Municipal Office in Břeclav, the Department of Building Office and Landscape Planning, was also used.

RESULTS AND DISCUSSION

The floodplain of the Dyje river above the town of Břeclav (Figure 2) was affected by a large, several days lasting flood in late March and early April of 2006 (Figure 3) (Hadaš & Litschmann 2007). This situation shocked not only the water managers but also all those who were managing this area, i.e. farmers, foresters, and the public usually enjoying favourable conditions for recreation and tourism. In fact, this territory had not been stricken by previously typical periodic floods since 1972. So the question is how and why this exceptional situation occurred. When evaluating the climatic data, it was found that the winter of 2005/2006 was rich in snowfall, and that the snow in the higher parts of the basin persisted until the end of March when a sudden warming up caused an intensive snow melting (Figure 4). The average daily temperatures always varied in the range below the freezing point from February until March 24th (except a few days). A gradual increase in the daily average temperature followed up to the values above 9.0°C from March 25th (April 1st), and

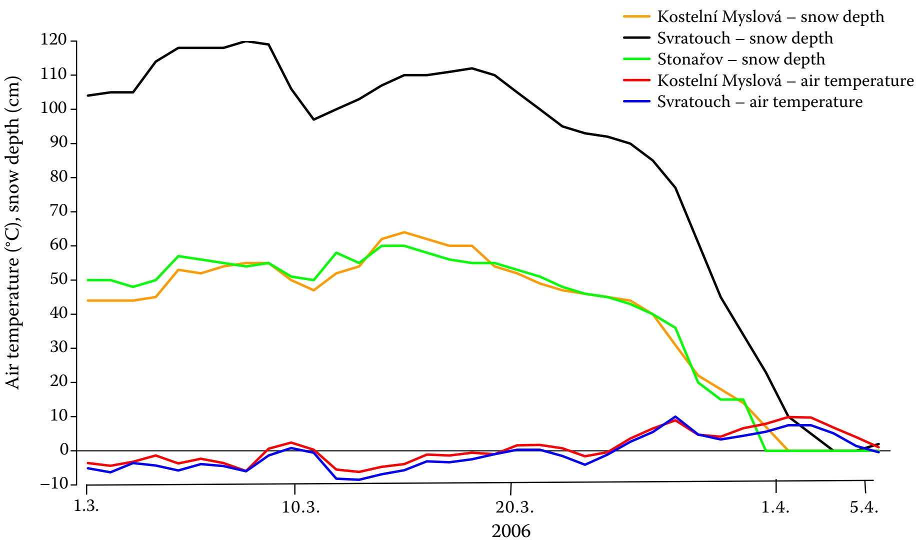

Figure 4. The course of snow depth in Kostelní Myslová (Dyje), Stonařov (Jihlava) and Svratouch (Svratka) localities and average daily temperatures in Kostelní Myslová and Svratouch in late March and early April 2006

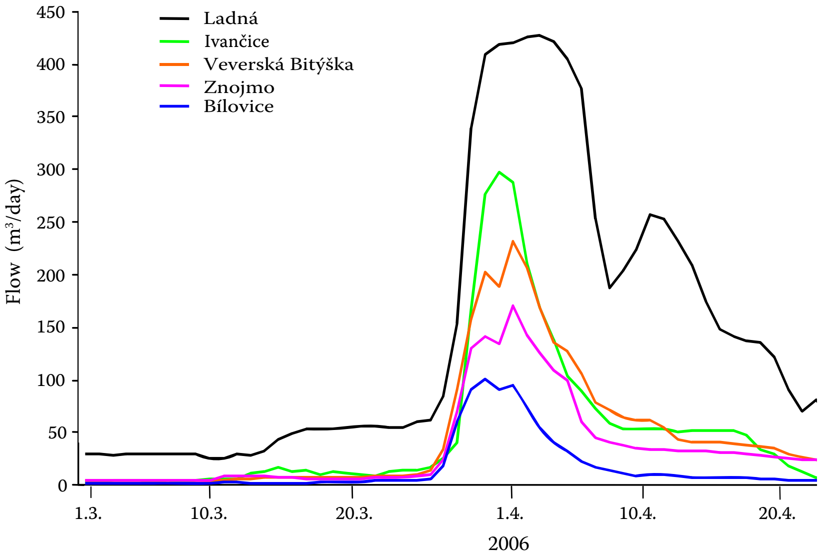

Figure 5. The course of flows in the Dyje river (Ladná, Znojmo), the Jihlava river (Ivančice), the Svratka river (Veverská Bítýška), and the Svitava river (Bílovice) in late March and early April 2006

during the next period the temperature did not drop below the freezing point any more.

The climatic data were obtained from the Kostelní Myslová station. A small amount of precipitation was also contributed to (Lednice na Moravě station on February 2nd – 22.1 mm). A sudden outflow of water from the entire basin occurred so that from March 30th to April 5th the flow rate at the Ladná station on the Dyje river (north of Břeclav) reached values significantly over passing 400 m^3/s. A flow higher than 600 m^3/s was measured on the Nové Mlýny dam. The precipitation itself could not cause so significant flows of the river at that time. The course of the flows on the Dyje river and the subbasins of the Jihlava, Svratka, and Svitava rivers in late March and early April of 2006 is shown in Figure 5. General characteristics of the Dyje river basin above the Ladná station including its major tributaries, i.e. the Jihlava, Svratka, and Svitava rivers, are given in Table 1.

It is clear that the basins of the Dyje river above Znojmo and the Jihlava river above Ivančice are roughly the same in a number of indicators, not only regarding the catchment areas. The Svratka basin above Veverská Bítýška is significantly different. Its area is half of those of the above mentioned

Table 1. General characteristics of the Dyje river basin above the Ladná station including its major tributaries

	River (Town)				
	Dyje (Znojmo)	Jihlava (Ivančice)	Svratka (V. Bítýška)	Svitava (Bílovice)	Dyje (Ladná)
Area (km^2)	2 499	2 682	1 480	1 120	12 280
Altitude (m a.s.l.)	513	486	548	486	419
Stream lenght (km)	160.5	151.1	100.6	80	261.4
Precipitation total (mm)	616	600	653	649	593
Average outflow (m^3/s)	129.8	135.4	169.8	147.6	107.1
Runoff coefficient	0.21	0.23	0.26	0.23	0.18
Runoff unit yield (l/s)	4.10	4.29	5.38	4.66	3.39
Average flow (m^3/s)	10.25	11.50	7.96	5.22	41.65
Maximum flow (m^3/s)	375	440	326	170	430
Basin character	0.10	0.12	0.15	0.18	0.18
Inclination (%)*	5.0	7.1	11.8	11.8	7.2
Forest coverage (%)	30	30	40	40	30

*according to Herbst; generally, these data are average values for the period 1931–1980; the values of the runoff and flow rates are affected by handling orders of dams on the rivers

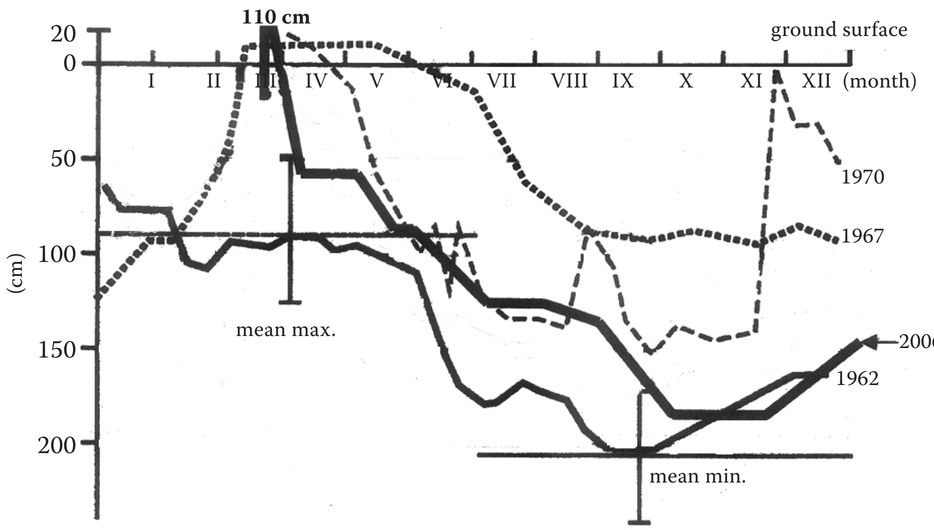

Figure 6. The course of the groundwater level during the floods in 2006 in comparison with historical data, Lednice station – Horní les locality

basins but shows higher average values in most parameters. Along with the Svitava river, it has the highest inclination (according to Herbst) and about 10% higher forest coverage. These four sub-basins of the Dyje river of a total area of 7781 km^2 generate the substantial part of flows on the Dyje river. The remaining area of 4499 km^2 is located in the flat territory of the Dyjskosvratecký Valley. The Litava and Trkmanka basins are situated there. Regarding the water yield, those basins are much poorer and their share in the water runoff during the floods was not so significant.

Another phenomenon that must be taken into account is the groundwater supply in the territory (Prax *et al.* 2008a). It is obvious that the groundwater level was very high (about 30 cm under the ground) just before the sudden flood, so the storage space for the water supply during the sudden river spill was easily and quickly filled (see Figure 6). Figure 6 also shows that, by the groundwater level dynamics, the year 2006 was similar to the years before 1972, when spring (sometimes even summer) floods normally occurred in this area. Figure 7 documents the situation after 1972, when the influence of the water management measures (the Dyje river channelisation) caused a downturn in the maximum monthly runoff in the Dyje river but also a slight increase in the minimum monthly runoff (Figure 8) (Prax 2004; Prax *et al.* 2008b).

It is obvious that the sudden flood described above had a certain impact on the sewerage net of the town of Břeclav and the surrounding villages. The conversion of the Dyje river maximum flow and prevention of the dam failure threatening the built-up areas of the territory were brought off. The Department of the Building Office and Landscape Planning of the Municipal Office in Břeclav assessed the situation as follows: The right-bank dam in the point of floodway branching was the

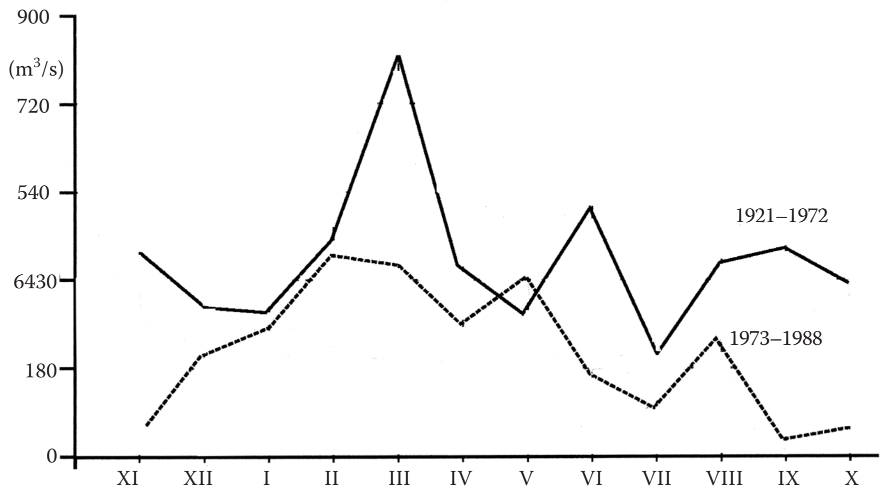

Figure 7. Monthly maximum runoff measured before and after the water treatments measures, the Dyje river in the village of Dolní Věstonice

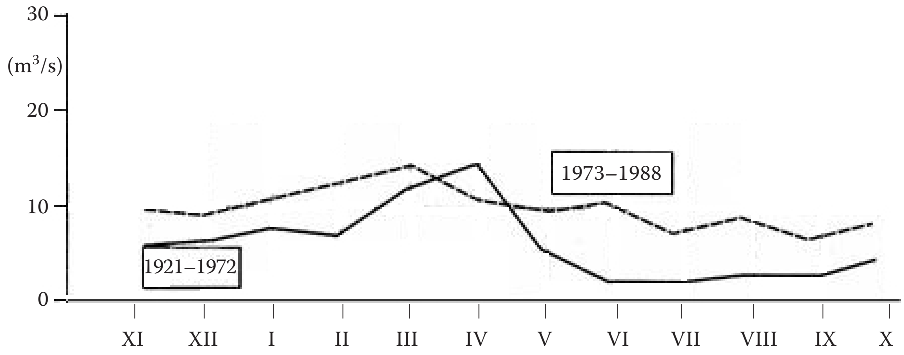

Figure 8. Monthly minimum runoff measured before and after the water treatments measures, the Dyje river in the village of Dolní Věstonice

most critical stretch. The highest seepage occurred in the left-bank dam of floodway in the town of Poštorná (Tatran area). There was a threat of dam failure. All dyke inlets and steam-shafts of storm sewer in right-bank dam of the Včelínek stream and floodway were filled up. Despite dyking there was a strong seepage flooding the land behind the dam toward the built-up territory. Subsequently, the installation of backflow valves was recommended. Sump piping was broken in a point of the makeshift dam in the village of Charvatská Nová Ves (the Včelínek stream). Subsequently, a new drainline and a pumping station were built there. After the floods in 2006, the caps in the culvert aqueduct were replaced and the capping pieces were raised above the 100 years water level in the intake areas in Břeclav and Lednice.

A new phenomenon threatening the flooding protection of the town and its infrastructure has currently occurred. An expanding colony of the beaver and its domiciliation in the protective dikes necessarily evokes the need of costly countermeasures in the form of special reinforcing dykes. From the above mentioned conclusions and in connection with the changing weather situations and other natural influences (beaver colony), it is necessary to care for the protective measures of the town and its infrastructure. The flood situation will return with a certain frequency as the flood of the spring of 2006 proved; however, it did not reach the peak flow of 1941. The floating situation in the countryside as well as in urban areas which reduces the retention capacity of the landscape in basins must also be taken into account.

CONCLUSION

A relatively short sudden flood, which threatened the town of Břeclav and its surroundings in late March and early April of 2006, had an interesting cause. It was not directly caused by an excessive rainfall in the region but by an unusual concurrence of climatic factors, i.e. fast melting of the snow cover in the upper parts of the basin due to suddenly increased average daily temperatures after March 24th 2006. High daily flow rates (up to 600 m^3/s) for about 9 days were recorded on the lower reaches of the Dyje river. The town of Břeclav itself was protected due to the flooding of the "dry polder" with floodplain forests and meadows above Břeclav. Except relatively minor damage of dykes and sluices and the need to build part of the new sewage net with a pumping station in the village of Charvatská Nová Ves, the sewerage system in Břeclav town itself was not noticeably damaged by this sudden flood. The 2006 spring flood was a warning that it is necessary to ensure the maintenance of the protective measures, because such a situation will repeat itself. This is due to certain changes of the climatic situation and anthropogenic influences in river basins which cause a reduction of the landscape retention capacity.

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