Learning to Live with Floods

WOJCIECH MAJEWSKI
Institute of Hydroengineering, Gdańsk
Polish Academy of Sciences
wmaj@cyklon.ibwpan.gda.pl

Floods play a predominant role among all disastrous natural occurrences. They have affected us in the past, they are a part of our present, and they will continue to occur in the future

In recent decades, people throughout the world have become increasingly alarmed by extreme natural events, the frequency and adverse impact of which both seem to be on the rise. Our problem is how to prevent floods whenever possible, to mitigate their negative consequences when they do occur, and to learn to live with them.

In the last decade of the 20th century, 1.5 billion people on our globe were affected by floods. During the period 1970-2000, three hundred floods were recorded in Europe alone. The rate increased from 5 floods per year at the beginning of this 30-year period, to 25 in the year 2000. Each of these floods resulted in economic losses reckoned in billions of euro, and also took a toll of human life. While such economic losses have been on the rise, the human death toll has been decreasing, thanks to improvements in the flood forecast system and better flood management.

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The inundated main railway station in Gdańsk

Floods in Poland

Poland has always had significant problems with floods. Recent years have seen considerable losses. During the 1997 flood on the upper Vistula and Odra, 54 persons were killed and direct losses amounted to 14 billion PLN, with indirect losses reaching 2.8 billion. In 2001, a flash flood in Gdańsk lasting four hours resulted in 200 million PLN in damage to the city infrastructure alone. Although 300 families lost their houses, fortunately no one in Gdańsk was killed.

Recent Gdańsk flow

The expansion of the city of Gdańsk in recent years has stretched towards the moraine hills to the southwest of the city, whose slope is directed towards the city. This area was used for new housing developments with new streets and parking lots, causing a decrease in the natural water retention capacity. At the foot of the moraine hills, there is a 13.5km-long artificial channel, called the Radunia Channel (RCh), built in the 14 century to supply the city of Gdańsk with water. Discharge in the channel is controlled by hydraulic structures. Its catchment, lying totally on its left-hand side on the moraine hills, amounts to 42 km^2. The channel has an embankment on the right-hand side and runs parallel to the main road leading to Gdańsk from the south. The area on the right bank of the channel is occupied by the old urban part of Gdańsk, lying in a depression.

The average annual precipitation in Gdańsk is about 600 mm, the July average being 68 mm. Precipitation in Gdańsk is highly non-uniform in space and time. There are frequent intensive rainstorms, which, however, cover only a small area. On 9 July, over a period of 4 hours (from 2:00-6.00 PM), practically the entire catchment area of the RCh received 80 mm of precipitation. The daily amount of precipitation on 9 July was 120 mm, a value estimated to have a likelihood of occurring once every 200-300 years. Simplified calculations indicate that the side inflow to the RCh from its left catchment area was about 100 m^3/s over 4 hours, while the conveyance of the RCh was estimated at 20 m^3/s. The total amount of water discharged in 4 hours to the RCh was about 1.4 mln m^3.

As a result of intensive precipitation, the following structures were destroyed or inundated:

- the embankment of the RCh was breached in 5 places, which resulted in flooding of the city area situated in the depression alongside the channel and the main road
- two main roads approaching Gdańsk from the West turned into torrential rivers

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The July 2001 flood in Gdańsk. Nowe Ogrody Street under water

- the main Gdańsk railway station was flooded, causing a one-week interruption in traffic
- the main embankment of the small reservoir on the Strzyża Stream was breached, which resulted in a severe flood along the main street and flooding of a crossing on the road between Gdańsk and Gdynia
- the dyke of the Kłodawa River was breached, thus causing flooding of a large area of agricultural land.

After the flood, the Institute of Hydroengineering of the Polish Academy of Sciences in Gdańsk was commissioned by the Regional Board for Water Management in Gdańsk to prepare an analysis of this flood and find a solution to prevent or mitigate losses caused by a similar flood in the future. A consortium was formed by the Institute of Hydroengineering, the Institute of Meteorology and Water Management - Maritime Division in Gdynia, the Hydroproject Design Bureau in Gdańsk and the GEOMOR consulting firm in Gdańsk. The project took more than one year to complete. This included taking exact measurements of all the streams, rivers and channels forming the so-called Gdańsk Water Node (GWN), performing hydrological analysis, developing a mathematical model of the GWN for hydraulic calculations, analyzing the results obtained, and proposing technical solutions to prevent disaster in the city in the event of precipitation on a similar scale.

Planning for the future

An analysis of the existing spatial situation of the city indicated that the present infrastructure prevented any general change in the network of channels in the GWN. No possibility was found for significantly increasing the conveyance of the RCh. Based on hydraulic calculations, it was decided that 18 small artificial impounding reservoirs should be constructed on all streams discharging into the RCh, in order to decrease the inflow to the channel during intensive precipitation. Simultaneously, it was proposed that 3 by-passes be constructed from the RCh to the Radunia and Motława Rivers to diminish the flow in the channel in the event of intensive precipitation. Two additional flood polders were also proposed, to be used in the event of an extreme flood situation.

A system of precipitation and water level gauges in the GWN was proposed, in order to create a flood warning system. All these measures are costly and their construction will take a long time, but there is, at present, no other solution. ■

Further reading:

Majewski W. (2004) World Water Day 2004, Water and Disasters. [in Polish] Gdańsk: Publication of the Institute of Hydroengineering

Majewski W. (2004) Flood in Gdańsk in 2001, Reasons, Run, and Mitigation Measures. *4th Study Conference on Baltex, 29*