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FLOODS IN THE RIVER VALLEYS OF THE EASTERN MID-EUROPEAN LOWLAND

POWODZIE W DOLINACH RZECZNYCH WSCHODNIEJ CZĘŚCI NIŻU ŚRODKOWOEUROPEJSKIEGO

Key words: river, valley, flood banks, water management, monitoring.

Summary: Throughout history, many times did floods in the river valleys of the East Mid-European Lowland occur. They brought about material losses and frequently generated hazards to human health and life as well. For centuries now, human communities have been building up flood banks in order to protect themselves against the negative impact of floods. The results of investigations into the flood banks along the Oder river, which were made during and after the great flood of the year 1997, point out to the necessity of their renovation. The outcome of the research work carried out in Poland may be used for the renovation and reconstruction of old flood banks and for the construction of new ones in the whole area of the East Mid-European Lowland.

Słowa kluczowe: rzeka, dolina, wały przeciwpowodziowe, gospodarka wodna, monitoring

Streszczenie: Powodzie w dolinach rzek wschodniej części Niżu Środkowoeuropejskiego występowały w historii wielokrotnie. Przynosiły one straty materialne, a często stanowiły zagrożenie dla zdrowia i życia ludzi. W celu ochrony przed ujemnymi skutkami powodzi społeczności ludzkie od wieków budowały wały przeciwpowodziowe. Wyniki badań wałów przeciwpowodziowych, jakie przeprowadzono wzdłuż rzeki Odry podczas trwania i po wielkiej powodzi w 1997 r., wskazują na konieczność renowacji istniejących obiektów. Badania wykonane w Polsce mogą być wykorzystane w renowacji i rekonstrukcji starych wałów oraz w budowie nowych obiektów na całym obszarze wschodniej części Niżu Środkowoeuropejskiego.

In spite of the fact that flood banks, in terms of their construction, are very simple structures, which have been built for many centuries, then frequently heightened, widened and lengthened, renovation of old flood banks as well as the construction of new ones in conditions altered by human activity, is still an engineering-geological problem, not only a technological one. Under the influence of the flood bank which has been built, the originally natural bottom of the valley is loaded, and thus becomes deformed; its porosity and water permeability change. The underground water table in the area before the bank, if the river was constantly draining, can be heightened, thus creating wetness of the soil, waterlogged areas and marshes, which were not there before, and which would not have been caused if an efficient system of drainage of the area before the bank had been introduced while building up the flood banks.

If the subsoil of the flood banks is marshy – as for instance is the case, when flood banks are built on the old river bed – then the peat and other kinds of organic soils are pushed away from under the flood banks, which results in their subsiding. In the event the flood banks are not correctly built, they may be destroyed even without a flood wave passing through the valley.

Engineering-geological recognition of the ground in the immediate neighbourhood of the flood banks can help local communities choose properly the soil to be used for the construction of flood banks.

Flood banks used to be built as constructions which were aimed at counteracting the harmful impact of flood waves – particularly those high ones. It is also possible to decrease the height, i.e. flatten the flood wave in a given cross-section of the river valley by means of a rational and integrated management of rain water and surface water in the river basin above the cross-section. This calls for creating flood control reservoirs, which will render it possible to stop the excess of rain and surface waters in periods of intensive rainfalls and to supplement the deficit of water in periods of drought. In such a case, the flow of waters in the inter-bank area can be equalised, i.e. it will not reach extreme values, and then the flood banks can fulfil their protective functions.

Although the existence of a human being and human communities of the Homo sapiens sub-species, as well as their ancestors, has always been connected with the possibility of having free access to drinking water, however the permanent settlement of individuals and human communities in the river valleys of the East Mid-European Lowland and on its river banks – as it follows from the dating of numerous archaeological relics – started only at the end of the Palaeolithic age and at the beginning of the Neolithic Age (approximately 4000 years B. C.). A primitive man in order to survive had to get to know the environment which surrounded him. He was forced to identify and tell what was harmful and what was useful for him. He had to learn to choose a safe place for his shakedown or permanent seat. Such a necessity to recognize and get to know the environment constitutes the starting point and nucleus of thinking, which today has developed into engineering-geological thinking in terms of localisation of an investment project [Rahn, 1986; Kowalski, 1988; Pflug, 1996; Scheffren, 1998 and others].

During the Neolithic Age, the eastern part of the Mid-European Lowland was overgrown with primeval forests. They acted as a huge storage reservoir for rain water. In the beginning of the Neolithic Age, rainfalls were even more intensive than today, but retention of water in the primeval, not thinned out forests was enormous. Only a small amount of rain water could flow down the inclines and slopes of valleys permanently overgrown with compact sod. This very sod did not allow the ablation of particles and grains of soil into the river beds, or in case of a heavy shower made it more difficult. Then clayey particles, dusts, sands, and sometimes even gravel carried into individual sections of river beds were lifted up and drifted away from these sections with the energy of water flowing in the river beds. Thus river beds were either stable, or their bottom subsided due to erosion of the bottom. The rivers were meandering and wound their ways. The waters of river beds hardly ever overflowed onto the lowest flood terraces. Human settlements at that time situated above the said flood terraces could not have been flooded or endangered by high flood waves. Under these circumstances there was no need for building flood banks. Floods started to threaten humans much later.

The vicinity of river beds provided inhabitants of permanent settlements, apart from access to fresh drinking water, with the possibility of easy transfer and transport along the rivers, incomparably more convenient than forcing their way through the primeval forests.

It is also worth noting that with time the energy of flowing waters has been used for operating water mills and forges.

There is no doubt that from the beginning of the Neolithic Age through the Bronze Age (approximately 1700 B. C.) and the Iron Age (from about 700 B. C.) till today higher and higher as well as more frequent flood waves have been observed in the river valleys of the East Mid-European Lowland. This phenomenon cannot be justified by climatic and weather changes observed in this period. They were neither big enough nor unidirectional to account for the intensification of floods. In the period under analysis, however, the numbers and population density increased in human communities inhabiting not only the river valleys, but also other regions of the Mid-European Lowland. At the same time, the area of farming fields as well as the depth of cultivation increased. Regular grazing of cattle on the same meadows and more and more numerous herds contributed to the destruction of the sod. These phenomena were accompanied by more intensive extirpation of forests which were not capable of self-regeneration, particularly in the period of primitive mining and processing of iron ores, which was based on using a considerable amount of timber.

Rain waters were originally retained almost totally in the forests, which were preserved in their natural state. Together with cutting down, burning down and extirpation of forests the retention capacity decreased considerably. A part of rain waters which were not retained, began to flow in a greater bulk down the inclines of the terrain and valley slopes towards the rivers and their tributaries, carrying bigger and bigger amounts of clayey particles, dusts and grains of sand and sometimes, due to a greater declivity of the terrain, even gravel, ablated from the areas deprived of overgrowth (forest and sod). The rock material ablated from the surface of the terrain was deposited on the valley slopes in the form of slope washes or alluvial cones. Sometimes it was drifted to other sections of the river bed. If the bulk of broken-up rock material carried to particular sections of the river bed was too big to be drifted farther on by the flowing water, then – either partially or totally – it was deposited on the bottom of the river beds, thus causing the level of the water flowing in the rivers to raise. The water, which was not held in the river bed, flowed over the river banks and flooded the lower flood terraces making them swampy. At the same time, with the river outwashes, the waters divided the originally compact river beds into several parallel beds of various size. In this way, the meandering rivers became transformed into brooklike rivers braided. The waters from the river beds – as the rivers were transforming from meandering to braided ones – more and more frequently overflowed their valleys. As a result of raising of the bottoms of river beds and due to river outwashes, the height of the flood waves also increased, thus endangering the previously safe human settlements. Thus it turns out that the frequency and height of the flood waves in the river valleys of the eastern part of the Mid-European Lowland is due to anthropogenic factors, to an extent not smaller than to those natural, i.e. climatic, meteorological and hydrological factors. On account of this considerable contribution of the anthropogenic factor, the contemporary fluviodynamic processes can and should be regarded as engineering-geological processes [Kowalski, 1988].

With higher and higher as well as more frequent occurrence of flood waves, which endangered permanent human settlements originally located in safe places, their inhabitants used to defend themselves by building up flood banks. Unfortunately, however, the work of building them up was carried out when the flood was already approaching and in a great haste, and thus materials in the immediate vicinity, those at hand were used. The height of the flood bank was connected inseparably with the width of its base and the gradient of the slope, which always approximated the gradient of natural slope of the built-up material. The gradient changes under the surface of the water, i.e. after the flood waveflowing, as it has been found out by observing the sapping and washing of the flood banks during flooding.

From the middle of the Holocene epoch., higher and higher flood waves occurred in individual sections of the river valleys of the East Mid-European Lowland. The first flood banks, which were built, with time proved to be too low. They had to be heighened, and also their bases had to be widened. As a rule this was done in the conditions of an impending threat of flooding, and the material for building the flood bank was collected from the area before the bank, and not from the inter-bank area. Thus the possibility of the occurrence of paludification and swamping increased which was due not only to infiltration of water from the inter-bank area through the flood bank to the area before the bank, but also to damming up of the ground water in the area before the bank. Neither was a proper technique of building up the flood banks always used due to the hurry and urgency of the situation. As a result, it turned out that raising up, widening and lengthening of the flood banks could not secure safety in particular sections of a valley. Successive floods followed, when the bulk of the flowing water destroyed the flood banks, or overflowed their crown if it could not be held in the inter-bank area.

Observations of river waters overflowing higher and higher flood banks crowns, which have been carried out for many years now, have led to the conclusion that it is impossible to build up flood banks of the height ensuring at all times successful protection against flood and its effects. It was observed that the conclusive meteorologic and hydrologic factors conditioning the alternate occurrence of heavy rain and drought periods in a particular river section are in the majority of cases located in the upper section of the river. Equally, increasing rain fall and surface water retention in the upper basin through building up high-water dams and polders in combination with proper water management in both natural and man-made retention reservoirs can, in a particular river section, prevent formation of destructive, high flood waves, or at least flatten them and in a period of drought direct the missing water amounts to the river bed. Rational management of water resources in the basin of a big river is not easy. Apart from many diverse factors, which are not explicitly stated, there may also be a clash of interests between communities inhabiting the basins of each of the tributaries and particular sections of the main stream valley. Undoubtedly, the results of the catastrophic flood of 1997, which occurred in the Oder river valley and its side streams in Poland, as well as in the territory of the Czech Republic and Germany would have been less destructive, if, prior to the flood, there had been an agreement made by and between the communities dwelling in endangered areas and local authorities being in charge of water management [Brezina, 1999; Dubicki, Słota, Zieliński, 1999; Chojnacki, 2000; Greinert, Kołodziejczyk, Greinert, 1998; Kołodziejczyk 2002 and others]. In the same year of 1997, in the basin of the river Vistula, as the result of more efficient water management, the flood wave was flattened and did not cause such damages as in the neighbouring basin of the river Oder. Hence, flood banks should be built and incorporated into the whole water management system as hydrotechnical structures.

It has been a rule that since the time the first flood banks were built the communities which have been using them as their protection against flood damages have only been concerned about the banks just before or during flood wave flowing. Thus, observations were made hurriedly and in a panic. As soon as the flood wave had flowed people stopped being preoccupied about the flood banks. Quite the reverse, they regarded them as obstacles in the communication between the areas before the banks and inter-bank area.

In the eastern part of the Mid-European Lowland the permanent monitoring of flood banks state and condition has been started only recently. Obviously, the process entails certain expenses. However, if we compare the costs of constant monitoring with the value of flood damages, we can prove that even lowering the level of the damages only by little will reimburse entirely the costs of long-term, well-organized and professionally run monitoring.

A good example of well-started and well-organized constant monitoring of flood banks are engineering-geological investigations into the state and condition of the flood banks in the Middle Oder Land which have been carried out regularly since the great flood of 1997. The results of the works done led to drawing up of a register of damages and harms in the flood banks caused by the high flood wave. Following the register, a documentation of the internal bank structures was worked out. It also referred to the ground foundation of the flood banks which must have cooperated with the banks and which provided materials for their formation. The investigations were carried out in 742 cross-sections, located along the so called Lubuski section of the river Oder. The investigations included such methods as: engineering-geological cartography, bioindication, electrical logging, hand drilling (2200 holes), sounding with SL-light auger and laboratory testing.

A complex analysis of the engineering-geological investigation results related to the flood banks in the Lubuski section of the river Oder reveals that flood bank body is distinguished by a great variety of soils, from which they were formed and, certainly, a great differentiation of the relevant engineering-geological parameters.

It was also observed that the condition of the flood banks under investigation is determined to a considerable extent by the sort and condition of the soils in the bank base. Finally, it was found out that the current condition of the flood banks depends not only on the method according to which they were formed, further strengthening of their structure and the influence of flood waters, but on many other processes as well. These are, first of all, numerous phenomena taking place inside the flood banks, such as: decay of plant residues, hollowing of tunnels by beavers, moles and field-voles, internal erosion and partly colmatage etc., as well as external processes such as using the flood bank crown as service roads, cattle grazing on the slopes, etc.

CONCLUSIONS

Condition, constitution and internal structure of particular sections of flood banks along the same river vary even on short sections and in some circumstances the differences are significant. The flood banks which have been formed for centuries are higher, broader and longer whilst the river is changing from meandering into braided one. The reasons for which the river has been changing from meandering into braided one in the area of the eastern part of the Mid-European Low -land were not only climatic, meteorologic and hydrologic changes, but also increasing forest thinning and the seasonal destruction. Maintaning, heightening, widening and lengthening of flood banks, as well as maintaining and building all the other hydtrotechnical structures (first of all connected with the flood banks), shoud be thoroughly planned, prepared and conducted regularly, not on the on-and-off basis just before the occurrence of the flood wave or when it has already occurred. Monitoring engineering-geological investigations of the flood banks condition should be carried out systematically, always during the occurrence of the high flood wave or directly after it has gone in the properly selected cross-sections by means of already known, simple methods of field and laboratory investigations. Comparing the costs incurred for the preparation procedures for the flood wave to come with the damages caused by several catastrophic floods due to negligence of correct protective undertakings shows explicitly that such protective measures are beneficial throughout all the period between the floods, and, as it has been proved, the related costs are much more smaller than the amount of damages caused even by only a single flood. Success of flood operations on the level of a commune, county, province, region and the whole country is determined to a considerable extent, by constant, not delayed cooperation initiated by and between flood committees on all administrative levels: communal, county, central, both within the boundaries of the country and in the neighbouring states. Effective operations carried out by flood committees on different administrative levels depend on rational management of rainfall, surface and underground water resources in the basins of small and bigger tributaries of main rivers (streams). Rational use of flood banks is possible only if we view them as hydrotechnical structures being part of water management system in a particular basin and a part of coherent water management policy in the whole country. The experience which has been acquired while carrying out engineering-geological investigations into the condition of flood banks ring the high flood wave discharge and after it has gone in the Lubuski section of the Middle Oder can be useful in planning similar investigations into the flood banks also in the valleys of other rivers in the eastern part of the Mid-European Lowlands.

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