Protection of Levees against Beavers

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Abstract. Beavers are a protected species, so the levees must be properly protected so as not to harm the beavers and protect the levees from the destruction caused by these animals. This protection requires the use of bentonite mats as shaft seals, and wire mesh. Recently, such new protection structures began to be used successfully.

1. Introduction
The endangered species in the past, rarely encountered nowadays – currently we hear more and more about the damage caused by beavers and growing compensation amounts. Repopulation of Eurasian beaver is a success in the eyes of biologists and naturalists. Unfortunately, what has been a success for some has led to new problems of flooding, destruction of crops and troubles with the maintenance of good flood protection?

On the basis of the Ordinance of the Minister of the Environment of 28 September 2004 on the preserved wildlife species, the Eurasian beaver (Castor fiber) was included in the group of partially protected species (Journal of Laws of 2004 No. 220, item 2237). Eurasian beaver was also classified as a Near Threatened species and was included in the 2007 IUCN Red List of Threatened Species. In addition, international law protects the existence and occurrence of this rodent, because it is on the list of species requiring special protection – Annex II of the Habitats Directive (Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). The major restrictions on beaver as a protected species include: the ban on killing, scavenging, and destroying them and their feeding grounds. The result is that any deviation from the prohibitions and locations of work and investments in the neighborhood of this species require authorization from the regional director of environmental protection in accordance with the Nature Conservation Act of 16 April 2004.

Beaver population in Poland has increased from 270 specimens to about 50,000 in the past 30 years. The return of beaver proved to be beneficial for the environment. The creation of floodplains as a result of the construction of dams locally led to an increase in groundwater levels. The composition of species of soil fauna and coastal flora has changed. From the natural standpoint, flowages caused by beavers increase the biodiversity and renaturalization of many habitats, previously drained as the result of human activity.

When a few beavers were brought to us from distant Mazury region in the early 90s, no one predicted that these animals would be a serious problem 20 years later. Every year beavers break more and more levees and cut down more and more trees, causing blockages in rivers, increasing the risk of flooding. – There are more and more beavers, we estimate that the population is more than 100 specimens. They occupy new areas, causing damage to the Cistercian park in Rudy, they are in
Łężczok and in the neighborhood of Racibórz. They are not a problem in the forest, but they can seriously damage the dikes by building their nesting boxes. – says Zenon Pietras, chief forester from Rudy. They acknowledge in the County Crisis Management Center in Racibórz that beavers cause damage by the Odra River.

“Animals cause losses. Some time ago, they cut trees in the vicinity of the Carbon plant that fell into the river, creating blockages. Beavers are protected, so we cannot disturb them” – explains Krzysztof Szydłowski, head of the District Center for Crisis Management in Racibórz. Tomasz Mainka, director of the Silesian Board of Land Melioration and Water Units in Katowice, admits that the animals have caused serious damage to the Łęgoń River, which flooded Turze last year. “Unfortunately, they are located in the nature reserve. But we have permission to dismantle the “constructions” they build. If we fail to do this by April 30th, we will have to wait until July, because of the protection season” – says Tomasz Mainka. He adds that beavers are also in Sumin and in the area of the Przegędza. “We have information that they are also in Racibórz on the Odra River. “We hope they will not do much damage here” – he adds. Meanwhile, in the Regional Directorate for Environmental Protection in Katowice, they explain that all of Silesia already has problem with beavers. “The largest populations are in the North of our voivodship, on the border with Świętokrzyskie, Opolskie and Małopolskie voivodships. But they are already in the South, too. They were caught and exported to Slovakia in 2007, but new ones appeared in their place” – says Tadeusz Podmagórski from Regional Directorate for Environmental Protection in Katowice. He adds that the Treasury pays for the damage done by beavers. “Indeed, they destroy the embankments, but this is only part of the truth. In many cases these flood protections are simply old, and not repaired for a long time. Beavers only somewhat help them to deteriorate” – says Podmagórski. At present, nets are used among other things for building new embankments, and they are a serious barrier to beavers, but even so, the animals boring in the ground strain the structure.

Unfortunately, what turned out to be good for the environment, has become a cause of conflicts with the world of man. Currently, the most important problems include:
- Flooding of meadows and cultivated fields caused by building dams and blocking culverts, ditches, and other hydrotechnical structures
- Digging of burrows and tunnels in the banks of water reservoirs and levees

Natural methods of solving problems with beavers include:
- Keeping a buffer zone of approximately 20–50 meters wide from water reservoirs where no intensive business activity is conducted
- Disassembling dams on the melioration equipment after obtaining appropriate permits
- Relocation of beavers from places where economic damages reach considerable size

While the first recommendation is difficult to implement – there is land which is not profitable, and often there are already economic investments or communication routes in the indicated area. The next two methods are only temporary: the dams will be quickly repaired, and the abandoned areas will be colonized by successive beavers. The existing situation forced changes in the design and construction of hydrotechnical devices and levees. New investments should be designed to prevent the beavers from destroying them. One should also carry out renovations of existing flood protection facilities.

2. Protection of levees

2.1. Fencing the levees

Installation of a zinc-galvanized steel mesh fence, at the base of the embankment on the side of the river, so that the structure of the embankment will not be affected. It is accepted to install the mesh with a mesh diameter of up to 10 cm, 15 cm maximum, and a wire diameter of at least 2.5 mm, a height of about 1.5 m, embedded at least 30 cm below the ground. It is one of the more economical solutions.

2.2. Steel sheet piling

Building walls made of steel sheet piles is a safe solution. It is the optimum solution for both the construction and strengthening of levees. Their low leak rate has been proven in practice. Sheet metal piles made by ARCELOR group from Luxembourg (hot-rolled and cold-formed) are among the ones available on the market. They are sunk using high-frequency mobile vibrators and hydraulic machines, therefore they do not damage the external environment. Also, a short installation time is an additional advantage. The steel from which they are made is homogeneous, plastic and environmentally safe – the material is subject to universally accepted standards. Steel walls are delivered as ready-to-use materials. It is not possible to break the continuity of the structure using sheet metal piles, which also optimizes the investment costs. Their application provides benefits such as: sealing and stabilization for new and existing levees; piling walls are a barrier against animals and tree roots; they also prevent landslides.

Sheet metal piles by ARCELOR used in flood protection structures in many European countries show that they are an economical and quick solution. Manufactured in accordance with PN/EN 10248 (Hot rolled sheet piling of non-alloy steels) and PN/EN 10249 (Cold formed sheet piling of non-alloy steels) and marked by manufacturer with the building mark B in accordance with applicable regulations. The part embedded in the ground is not susceptible to corrosion – a loss of thickness of 0.03 mm/year is assumed in normal conditions.

Steel piling has been known for many years, but the search for more economical solutions has allowed for the development of a new type of anti-filtration barriers – EcoLock vinyl piles made by the Pietrucha Group. One can use three methods for the installation of EcoLock vinyl piling: pile driving using a vibration hammer, jetting, and trenching. A steel guide, which is also called a mandrel, is used in difficult ground conditions or a significant length of the sheet pile. They are also an ecological
solution – they are made of recycled plastic and do not react with the substrate. No corrosion, many accessories and the capability to produce profiles in any color, all allow for an aesthetic design.

2.3. Metal meshes, cell geogrids

Covering levees serves as a protection against animals biting into it. Digging dens, burrows, and communication channel systems structurally weaken the embankments. In the case the water level raises, flooded tunnels contribute to the rupture of the embankment. Metal mesh has to be laid on the embankment cleared from bushes and unevenness so as to ensure adhesion and mounted using steel anchors with length of at least 50 cm, at least 1 anchor per 1 m of mesh. Individual mesh sections shall be permanently fixed using of galvanized steel clips. Recommended parameters: the maximum mesh size of 10 x 10 cm, the minimum wire thickness of 2.5 mm.

Cell geogrids with large mesh, filled with coarse aggregate, e.g. boulders. It provides effective protection against animals and does not inhibit plant growth. In addition, it is necessary to apply a geotextile filter on both sides in order to prevent washout of soil grains.

2.4. Bentonite mats

Bentomat is a geocomposites with self-sealing properties. It consists of a leak-proof bentonite granulate, sandwiched between two pieces of geotextile. Widely known for its swelling properties, it is resistant to cracking and breaking. Additionally, swell able bentonite exhibits self-sealing properties, i.e. seals break caused by rodents or growing tree roots. Another advantage is a simple and fast installation, which consists of unrolling and overlapping, without joining or welding.

2.5. Vertical barrier made of bentonite

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Figure 2. The author’s version of the levee protection using a bentonite mat
This technology consists in the use of a bentonite mat as a vertical isolation of the embankment. Its use is recommended in cases when it is not possible to modernize the embankment slopes. The capability to perform works using common construction equipment reduces the cost and mitigates emissions of vibrations and exhaust gases to the environment.

The use of a mesh for the protection against large rodents. Macmat® R Steel is a double-interleaved steel wire mesh in a polymeric shell with a polypropylene geomat with a spatial structure extruded on it. The mechanical properties of the steel reinforcing mesh exceed the requirements of EN-10223-3. The steel wire is secured by Galmac coating (ZnAl 5% in class A according to EN 10244-2) and an additional polymer coating in accordance with EN 10245-2 [5]

3. Conclusions
These applications of new technologies and the introduction of protection against animals allow the strengthening of flood protection. In addition, they reduce the cost and frequency of repairs.

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