IMPACT OF BEAVER PONDS FOR ACCUMULATION OF DEPOSITS

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Abstract: Beaver ponds, just like reservoirs, lead to accumulation of redeposited deposits, which may have different fractions. The depth of these deposits can be differentiated and it can depend on the direct sedimentary area. The deposits connected with the activity of beavers were found in Poland. When comparing with the investigation led in the United States it is possible to notice a kind of dependence. The bigger maintenance area, the bigger supply of deposits and their depth. The research carried out by the author concentrates so far on the deposits accumulated contemporary on the area of Bory Tucholskie (forest area in Poland), where the supply of sedimentary deposits is difficult (because of the forest area) but on the other hand, in the past, in different periods could be more intensive. In the analyzed beaver ponds, created on the streams, fluvial deposits (sands with depth 5-25cm) and reservoir deposits (loam and organic deposits with depth 2-5cm) are accumulated. Measurement of the depth let to creation of a three-dimensional structure of the deposits in the pond. The structure turned out not to be regular. It points to some extra factors, which have some influence on the sedimentation e.g. changes of the water-table level.

Key words: Bory Tucholskie, **beaver, beaver ponds, beaver dams, stream, sediments**

1. Introduction

On the area of Bory Tucholskie the occurrence of European beaver (Castor fiber L.) is connected with reintroduction, which was carried out in the 1970s. On the area of Wdecki Park Krajobrazowy (landscape park in Poland), which is a part of an investigated area, beavers were localized in 1976 (Rurek 2007). The most frequent examination of this mammal, as the geomorphologic factor, today and in the past has come from the United States (Butler, Malanson 1995; Butler, Malanson 2005; Perscio 2006). Also in England (Wells 2000) the first appearance of the peat bogs, dated 800 BC, is assigned to the beaver activity. As showed by the mentioned authors, beavers can adapt the natural environment, by changing it, to their needs. They occupy the river valleys (Kobojek 2005, Witt 2000), watercourses (Rurek 2007), source gaps (Rurek 2007), moraine uplands and sandy plains (Pupininkas 1999). However the most frequent occurrence of beavers points to their domination in the mountain areas (Butler, Malanson 1995; Kobojek 2005; Persico 2006). The activity of beavers is connected with the damage of the surrounding area. The bigger number of people is demanding compensation from the local governments. Beavers by building dams, which accumulate water on wide-spread areas, influence the formation of peat bogs (Tobolski 2003). By doing that they contribute to irrigation of the surrounding meadows but on the other hand they also create convenient conditions for creating new water ecosystems.

2. Methodology

In this paper there was an attempt to calculate the amount of material delivered to the beavers' ponds. The surface of ponds and the length of dams was measured. With help of cores the depth of deposits in active ponds was defined. Lack of water in two ponds helped to create the three-dimensional arrangement of material. The examinations of these ponds were carried out in July and November. Taken pictures (*Figure 3AB)* show the range of a pond and the distribution of deposits. The supply of the material on this area is difficult. The biggest depth have sandy deposits (5-25 cm) but organic 2-5 cm. It is mostly fine and medium sand, and organic are the remains of plants deposited in loam. The author concentrated mostly on examination of sandy deposits. As mentioned before, the supply of deposits is difficult because of the vegetation. The volume of material from the beaver burrows has been calculated. It was based on a formula of a cylinder volume (1) where r = radius of the burrow's diameter, h = length of the burrow.

$$V = \pi r^2 h \qquad (1)$$

For example, the calculations of the deposits from the burrows, based on the given formula (1), which are only 10 m long and 0,3 m in diameter can deliver 4,7 m^3 of sand. In this case 'r' and 'h' are variable. The

length and the diameter of analyzed burrows were as follows: 15-20 m of length and 0,3-0,5 of diameter. That is why in both cases the average was taken (length – 17 m, diameter – 0,4 m). The achieved data showed that the participation of deposits from the beavers' burrows is crucial and it is about 16 m^3. Landslips are the other source of deposits. Three places (*Figure 5),* where the side erosion caused by the accumulation of deposits led to undercutting the slope, were located on the analyzed watercourse. Probably there are 2 m^3 max of deposits from the landslips. The biggest depth of deposits is located in the supporting ponds. They fill the riverbed and rise the level of river bottom *(Figure 3B).*

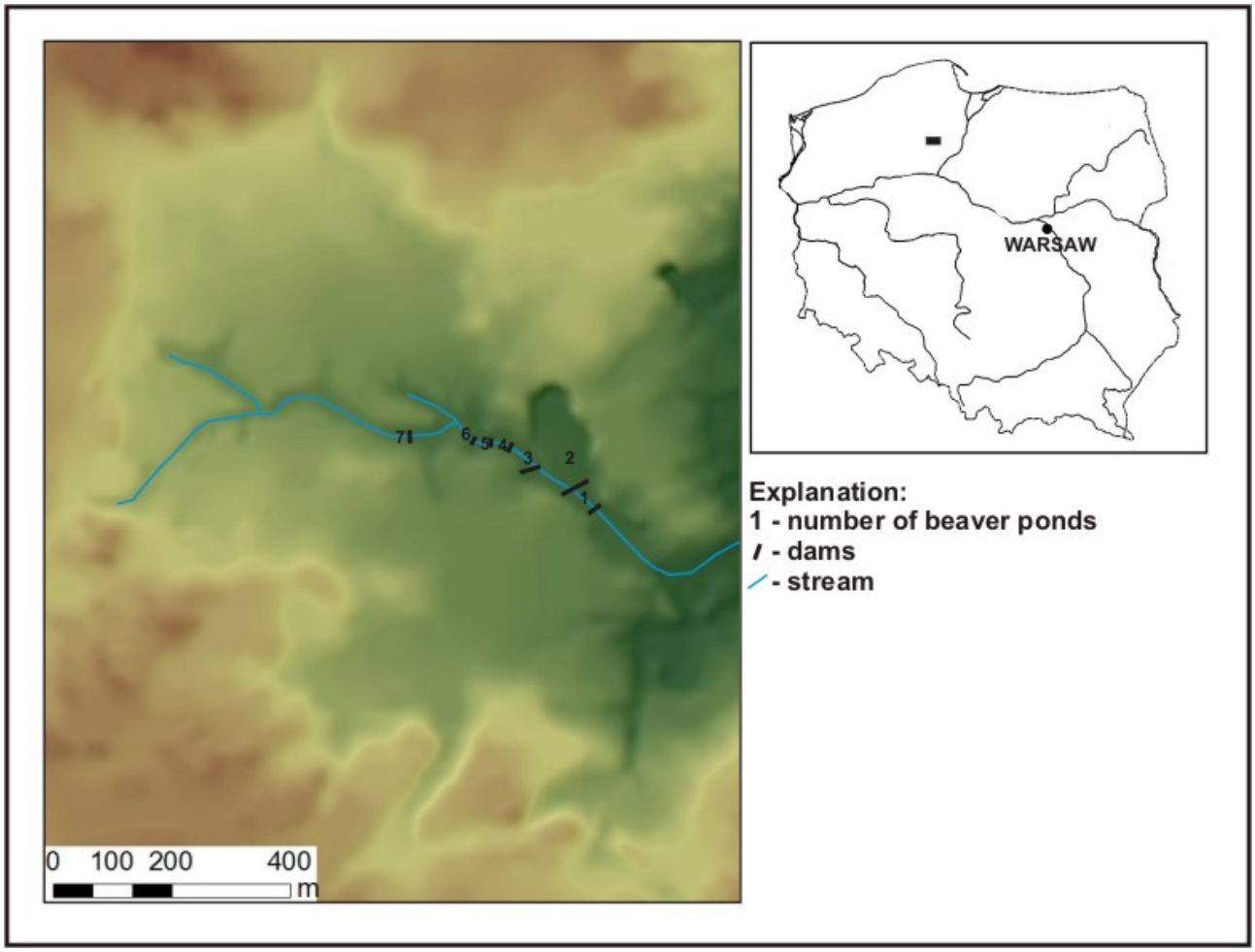

Figure 1. The investigated area on the map of Poland.

3.The investigated area

The investigated area is located near the village called Trzebciny in Tucholski district *(Figure1)*. It is the area shaped during the last glaciations thanks to fluvioglacial water. It created one of the biggest outwash on the Polish territory – outwash called Brda. The outwash is mostly, however not completely, covered with pine forests. The areas without trees are called moraine islands. They are used for farming. The surface of the outwash is cut by valleys of different sizes. They create the suitable place for existence of beavers. The population of this mammal is growing successively on the analyzed area. The watercourse mentioned before transfers water through the forest area to Wda River.

4.Sedimentation in beaver ponds

The material embed in all localized ponds. The depth of deposits is between 0,05-0,25 m. Data connected with ponds is showed in *Table 1*. Ponds are created on the watercourse which has a riverbed filled with water. Therefore the low surrounding areas are flown. First type of ponds are called supporting ponds (numbers 4, 5 and 6 on the *Figure 2*). They only have the riverbed flooded and the deposits are often accumulated near the riverbed after the repeated indentation. Second type ponds are the ones in which sandy and loam deposits are accumulated. These ponds cover bigger area than the former ones. Sedimentation depends on the environment in which the process of supply is carried out. On the mountain area in the United States the volume of deposits is bigger and it is about 500 m^3 per year (Butler, Malanson 1995). On

the mountain area in Poland, especially in Bieszczady Mountains (Derwich 2007), deposits accumulated during five years of ponds' existence can have depth from 0,13 m to 0,45 m.

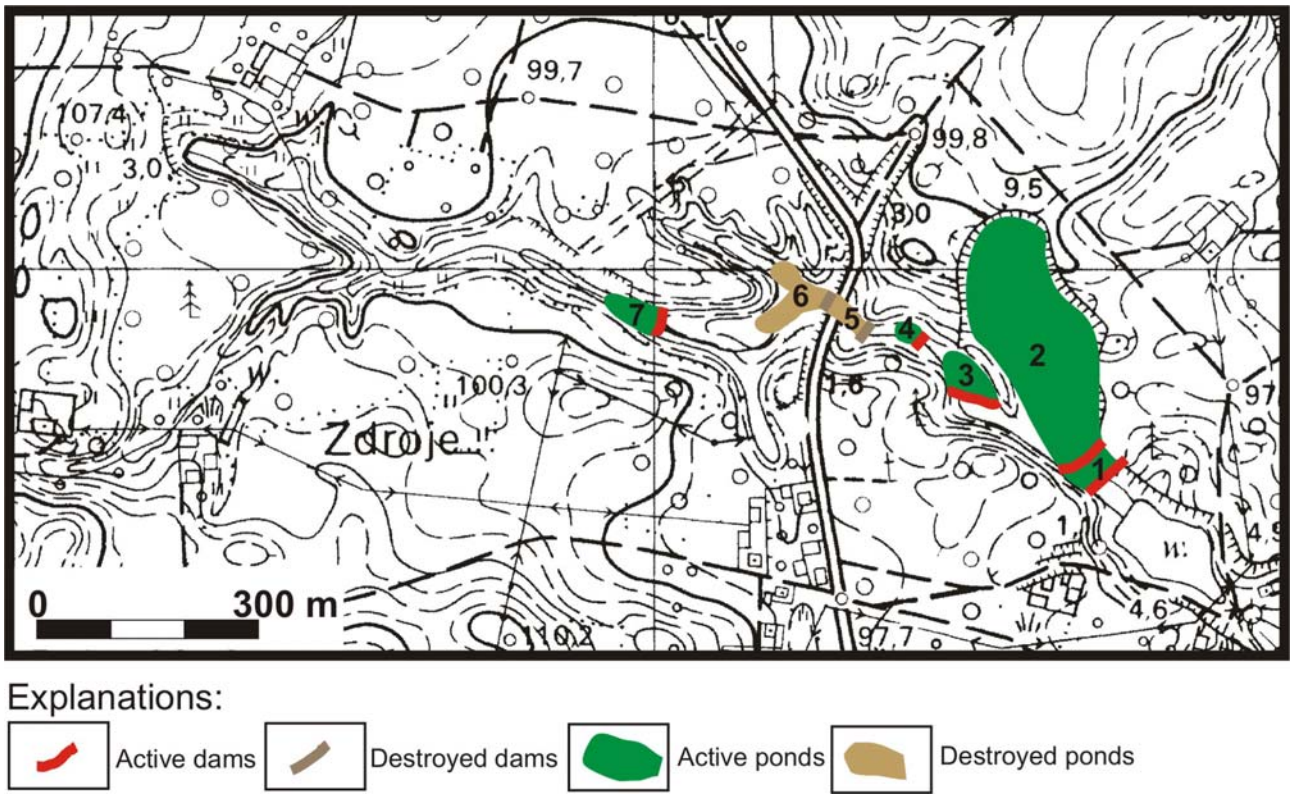

Figure 2. Beaver ponds localized on the stream.

Even though it is the mountain environment the discrepancies are quite big. The oldest among the analyzed ponds are about 3-4 years. Comparing the data with Derwich's (2007) examples it can be

Figure 3. Beaver pond no 6 (see Figure 2) in different seasons. Picture A was taken in July after the pond was created. Picture B was taken in November after letting out the water. It shows the levels of deposits' accumulation.

assumed that the rate of deposition is similar although, in all ponds, examined by him, the depth of deposits goes over 3000 m^3. The surface of ponds described by Derwich (2007) is in general bigger from the ones analyzed in this paper. Among them the biggest one is a pond No 2, shown in *Figure 2.* Derwich (2007) does not describe such a big pond. The analyzed ponds do not keep such a big amount of deposits. The biggest pond is not located on the watercourse. Only organic deposits are transported to this pond and that is why it has perfect conditions to create peat bogs. The ponds, according to the calculations, accumulate about 350 m^3 of deposits per year.

4.1. Characteristics of ponds – deposits

Table 1 shows the detailed data connected with ponds. To build dams beavers used deciduous trees from the surrounding area, especially willows, poplars and hazels. The ponds have different sizes. The biggest one is located on the watercourse. It is possible to notice that the depth of deposits is also different. Apart from this, three-dimensional distributions in ponds with bigger surface is not always the same because of changes in the level of water during different seasons of a year. The outflow depends on the water supply. The watercourse is mainly supplied by water from source gaps. There is no visible backward erosion. The supply of deposits is minimal. Only organic deposits like branches and leaves from the surrounding area are supplied to the ponds.

Number of pond	Pond area (m^2)	Dam lenght (m)	Sediment depht (cm)	Time of function ponds
1	100	13	5	4 year
2	2000	15	5	4 year
3	600	26	15	4 yaer
4	30	3	20	1 year
5	15	3	20	4 months
6	370	2	25	4 months
7	400	20	15	4 year

Table 1. Characteristic data on beaver ponds

4.2. Burrows

There were not any lodges in any pond on the examination area. Beavers live in chambers dug in high slopes.

A  B 

Figure 4. The inside of beaver burrow. Picture A shows the active burrow with the diameter of 30cm. Picture B shows the damaged one with diameter of 50cm.

Their burrows, which have entrances under water to prevent enemies in localizing them, lead to the chambers. There are a lot of buried burrows near the watercourse. They are a possible trap for animals living in them. The share of deposits from the burrows, as showed the carried out calculation, is big. The results given in chapter 2 (*2. Methodology)* are only about the burrows which were accessible to measure. The proper length of burrows remains a secret. There are described cases in which the length of burrows is over several dozens (Brzuski, Kulczycka 1999). *Figure 4* presents pictures of burrows. The burrows are mainly

from 40 to 80 cm under ground (*Figure 4A*). First they are dug more shallow but because of weight and soil processes they collapse. In the soil profile it is possible to notice a well-formed crosswise profile in a shape of **U** (*Figure 4B*). The diameter of analyzed burrows was from 0,3 to 0,5 m. The rest of gnawed branches, which were the rest of food, were found in burrows.

4.3. Erosive activity

Water, which is flowing through the sides of the dams, causes undercutting of high slopes. There are three places like that localized on the analyzed area. *Figure 5* presents the biggest of all landslips. It is 2,5 m high and 4 m wide. The depth of fallen ground was about 0,4 m. From this landslip comes about 2 m^3 of sand. Forms like these create good places in showing geological construction. Suitable conditions to create such geomorphologic phenomenon exist on the analyzed area. When the new ponds are created the high slopes start to be undercut and as a result new landslips are formed. It happens because fluvioglacial deposits dominate in the geological construction. The depth of mentioned deposits comes to 10 m.

Figure 5. Beaver pond no 4 (see Figure 2). The side erosion caused the landslip.

5. Conclusions

As presented in specialized literature the activity of beavers has been since a long time observed and analyzed. On the analyzed area has been formed so far seven beavers' ponds on one watercourse. It means that transformation of environment at this place is the biggest. Although the existence of beavers has been localized in different places not elsewhere was the same structure of ponds as on the analyzed area. Unresolved remains the question of the amount of supplied deposits and calculation of total volume of deposits in ponds. The volume of deposits from the burrows is small when compared with the total amount of deposits. It points to bigger participation of burrows than it was believed before. Maybe in future, with the use of different methods, it will be possible to measure the total length of burrows.

Three-dimensional distributions of deposits in a main whole pond is not always the same and it depends on changes in the level of water during a given season of a year. Dam breaking quickens the process of erosion. It is stated that after dam breaking the amount of deposits accumulated in one pond (supporting pond) accumulates in the next pond. After letting out water from the ponds the characteristic oblong and stair profile, which is not always visible, is formed. Relict deposits have not been described yet in Polish literature. However descriptions like that referring to the results of C^{14} date come from the United States (Perscio 2006). The usage of C^{14} date is crucial to determine the absolute age of deposits, which will be found in future. The archeological sources could be useful. However, when talking about the discussed research area there is not enough of them. The archeological sources describe found animals' bone remains. Therefore it can be a key to find the areas colonized by beavers in the past.

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