CURRENT CONDITION OF IRRIGATION SYSTEMS IN SELECTED TERRITORY

MILAN JIROUT[1], VERA HUBACIKOVA[1], FRANTISEK TOMAN[1], MILADA STASTNA[1], HELENA HANUSOVA[2]
[1]Department of Applied and Landscape Ecology
[2]Department of Plant Biology
Mendel University in Brno
Zemedelska 1, 613 00 Brno
CZECH REPUBLIC

milan.jirout@mendelu.cz

Abstract: This paper aims to map the state of the irrigation system in the selected area and the evaluation of its components. The area of interest is located near the Malonínský brook near the town Jevíčko. As part of the elaboration of the work methodology historical material has been obtained from the flow manager and the local government, which has been preserved to the present day. In addition, the area of interest was visited (in October 2016, March and August 2017), reconnaissance of the terrain and photo documentation of the current state of the constructions were realized. The collected information was processed and evaluated. In the area of interest there are 6 categories of constructions of surface watering system Malá Haná, which was built in the 1930s. This system is currently largely non-functional outside Smolenská Water Reservoir, which is maintained in a conditional state, and as the only one of the original irrigation system can be used for other functions or possibly incorporated in the future into a new irrigation system based on modern austerity technologies.

Key Words: soil irrigation, water retention, ditch, dam, watercourse

INTRODUCTION

Reasons of irrigation

Agriculture is a significant user of water resources in Europe, accounting for around 30 per cent of total water use. Irrigation can have two main purposes in relation to agricultural production: It can enhance the quantity of output; It can enhance the quality of output.

Allowing sufficient crop yields to provide food for humans and their livestock is the main reason for building the irrigation. According to Czech state standard 75 0140 (2016) irrigation is the artificial supply of irrigation water, sewage, fertilizers and other solutions for the maintenance of water needs and plant nutrition or for other purposes (Dwyer 2000).

The purpose of irrigation is to produce crops that have economic and social value. The continued productivity of irrigated agriculture will be critical as national and world populations grow and demand more food and fiber. Properly managed irrigation can increase crop yields, reduce risks commonly associated with agriculture, increase product quality, reduce pest pressures, and precisely deliver and manage nutrients (USDA 2001).

Division of selected irrigation systems according to CSS 75 0140 (2016):

Furrow irrigation is the way in which the soil is irrigated by soak from any of the irrigation furrows.

Infiltration irrigation is the way of irrigation, where the soil is moistened with any water from channels, ditches, furrows or underground pipes.

Spraying irrigation is a method of irrigation where water is sprayed on the irrigated surface in the form of rain.

Surface watering is a method of irrigation, in which the water flows down the surface of the soil in a thin layer, while enhancing it. There is a distinction between irrigation by belt, sallow, ridge and recesses from channels.

Flood irrigation is a method of irrigation, in which the irrigated plot divided into a lift is flooded with water.

Drip irrigation is a localized irrigation with a water distribution system with small diameters, from which water flows through batch elements such as drippers, streams, capillaries, etc. to the surface of the soil with low intensity, and softens the soil at the root ball of the plants.

MATERIAL AND METHODS

Methodics

This paper aims to map the state of the irrigation system in the selected area and the evaluation of its components

The area of interest is located near the town Jevíčko. The methodology of work and assessment of objects was compiled for the elaboration of the paper. The flow manager and local authorities have provided historical materials that have survived to present. The original design documentation of the irrigation system at the site was not retained. In addition, the area of interest was visited (in October 2016, March and August 2017), reconnaissance of the terrain and photo documentation of the current state of the constructions were realized. The obtained information was processed and evaluated using computer technology at the Department of Applied and Landscape Ecology.

Definition of the interest area

The selected area is situated to the west of the town of Jevíčko, located on the south-eastern edge of the Pardubice Region. Jevíčko is located 15 km south of Moravská Třebová and 16 km north of Boskovice. The area of interest is defined by the area of the area along the Malonínský brook from its confluence with the Jevíčko stream on the III/36612 road bridge, which is run over the Malonínský brook near Smolenská (see Figure 1).

Development of irrigation in the area of interest

Due to the fertility of Malá Haná, agriculture has been developed in this area and, at the same time, land improvement. The first officially recorded planning efforts to implement amelioration measures have been recorded since the mid-18th century. At the beginning of the 20th century, livestock farming was expanded, for which sufficient food had to be ensured, and at the same time the need to increase the protection of the area (especially crops and drying hay in the meadows) from the damaging effect of the floods. It was also necessary to drain the wetlands. This was the reason for the development of projects and the subsequent construction of the surface watering and flush irrigation systems. The irrigation system was built in the 1920s and 1930s (Coufal 1935).

The built system was unique in its time throughout the Czechoslovak Republic. At the same time, the construction of the meadow land was carried out in all the cadastres in Malá Haná, where it was built, and the fields were merged in several other cadastres.

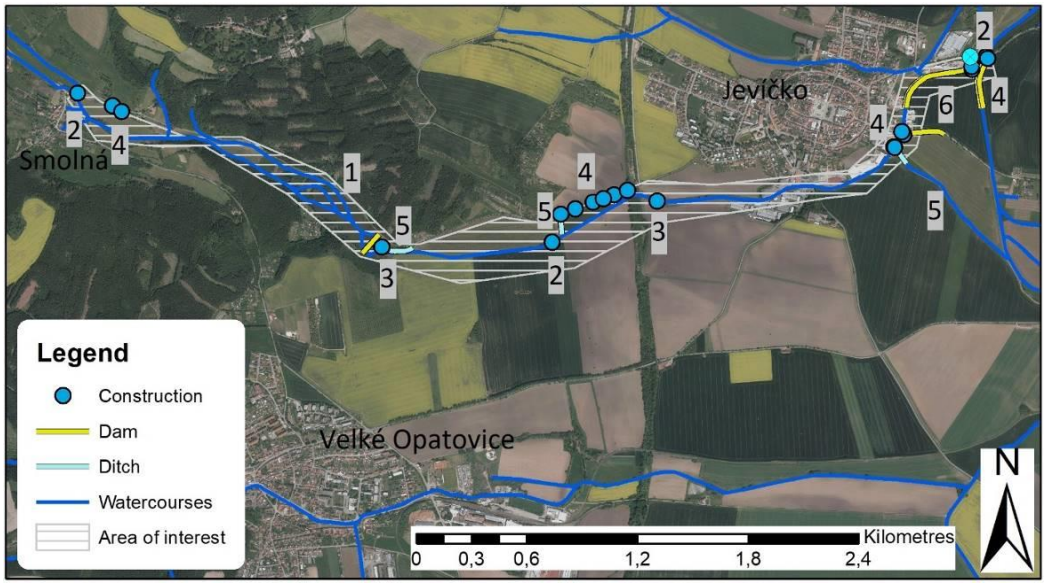
After the Second World War, the water irrigation from the Malá Haná area was abandoned, the built-up channels were mostly covered, but the concrete bays were left both in the flow channels and in the places of the irrigation channels. In the conversion of meadow cultures to arable land, surface watering was abandoned because of the increased use of mechanization and the possible replacement of the system by other modern solutions at that time (Benetin 1979). At present, all the buildings outside the Smolenská reservoir are dilapidated.

RESULTS AND DISCUSSION

Evaluation of irrigation system components

Several components of the surface watering system were identified in the area of interest and divided into six categories. The preserved components are shown in Figure 1.

Figure 1 The interest area with irrigation constructions.



Legend: Orthophotomap: Czech Office for Surveying, Mapping and Cadastre. Modified by author.

1 – Smolenská water reservoir

The Smolenská water reservoir is the main landscape-forming element in the area of interest and served as a source of water for the irrigation system in a period with a lower flow of water in the Malonínský Creek. Smolenská water reservoir in year 1933 is shown in Figure 2 on the left.

Figure 2 Smolenská water reservoir in year 1933 (on the left), Smolenská water reservoir in year 2017 (in the middle), A bridge with a floodgate at Jevíčka stream in 1933 (on the right)

At present, the reservoir is supplemented by a sedimentary pretension, which was established by the State Ameliorative Administration for the detention of the floodplains before entering the Smolenská reservoir. Together with the pretence, a pool was built at the inflow to the reservoir to increase the biodiversity of the area and support amphibians. In 2009, the Agricultural Water Management Administration completed the reconstruction of the security spillway and the discharge facility. At present, the Smolenská reservoir and the preserve are discharged due to the filling of the preload and the subsequent flow of the spills directly into the reservoir. A project to unload the reservoir and to reconstruct the discharge objects is being prepared. The current reservoir manager of adjacent streams is the Povodí Moravy s.p. Smolenská water reservoir in year 2017 is shown in Figure 2 in the middle.

Smolenská reservoir is currently the most conserved part of the original irrigation system. After measures to prevent settling of the sediment in the reservoir and its removal, the capacity of the reservoir will increase and therefore this higher capacity can be used for the supply of any newly built irrigation system or it will be used as a capacity to capture and transform the flood flows on the Malonínský Creek.

2 – The road bridges with the sluices

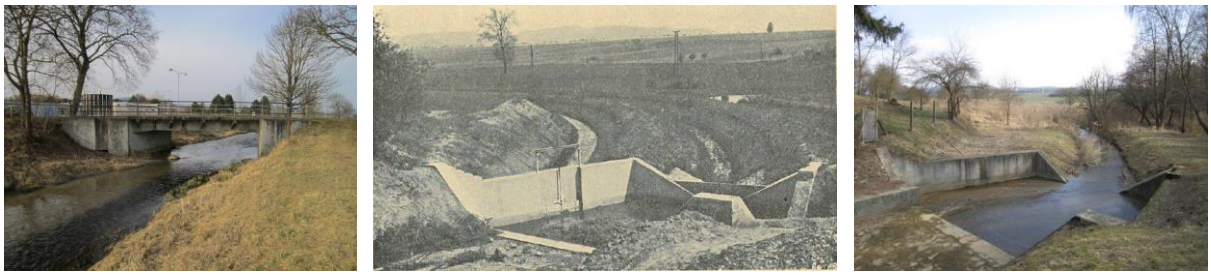
Water gates in road bridges or stand-alone were used to draw water from the watercourse. The bridges are concrete constructions, the control elements of the building were made of steel and a steel frame with a wooden panelling was used for the floodgates. The water was fed to the flood

drifts when the flow was blocked. The floodgate weir on the road bridge of the Jevíčko-Biskupice road had three fields with a height of shutters of 1.1 m. The sluice in the area over the highway had two fields with the lightness of 4.2 m and shutters 1.4 m high. Floodgate on the bridge in Smolenská had two fields with a shutters height of 1.48 m (Pernica 1997). A bridge with a floodgate at Jevíčka stream in 1933 is shown in Figure 2 on the right.

However, after the irrigation system was shut down in the post-war period, the flood shutters remained, as it was part of the road bridges, which were further used. In order to reduce the negative impact of the technical objects in the riverbed and due to the poor condition, during the period of stewardship of the State Melioration Administration, water gates were removed, only the bridges or concrete frame structures remained. For interest, some municipalities have wanted to keep the floodgates on the rivers for possible utilization of the accumulated water as fire water. A bridge with a floodgate at Jevíčka stream in 2017 is shown in Figure 3 on the left.

At present, the sluices in the road bridges are not functional and are not used even for emergency fire water accumulation. Comprehensive reconstruction will be required to ensure operational condition as part of road communications.

Figure 3 A bridge with a floodgate at Jevíčka stream in 2017 (on the left), A floodgate at Malonínský stream in 1933 (in the middle), A floodgate at Malonínský stream in 2017 (on the right)



3 – Independent floodgates

These objects were made up of a simple reinforced concrete structure with embedded steel elements for controlling and the possibility of reserving buoys. The shuttle in the area under the highway had two fields with a lightness of 4.2 m and a window height of 1.1 m. The floodgate at the mill was situated in a location under Smolenská reservoir on the tranquillity reservoir (Pernica 1997). A floodgate at Malonínský stream in 1933 is shown in Figure 3 in the middle.

At present, only a concrete structure that no longer contains steel elements or screens remains at the site under the motorway. The floodgate in the area under the Smolenská reservoir was partly removed during the reconstruction of the safety spill in 2009. A floodgate at Malonínský stream in 2017 is shown in Figure 3 on the right.

At present, these objects are not usable or do not exist. The mill drive was cancelled and the trough was covered.

4 – Setting devices, drains and aqueducts

The setting devices served in their full engagement to retain and drain the water in the pots and to create a drop of water across the meadows. The setting devices were made of concrete with a hole for a wooden stopper. The area around the bucket was tiled with tiles. The length of the overflow edges from the drive was 40–80 m. At present, the trays on the meadows above Smolenská Reservoir and in the area above the highway are preserved. At present, these objects are unjustified because the drives on which they were located no longer exist. Setting device at none exist drive in 2017 is shown in Figure 4 on the left.

Drains were an important part of localities where watercourses were lined with a low hill. So, the water could drain away. Nowadays the drainage is located in the embankments around Jevíčko, they are in a reserved position and do not fulfil their function. They cannot even perform a flood-proof function because the adjacent decks are no longer properly shaped and damaged in several places. They are more or less technically interesting object in the landscape. Example of drain in 2017 is shown in Figure 4 in the middle.

In the area of interest there is the last aqueduct in the area above the highway. This aqueduct served to transfer the drift stream over the waterline at another height level. Currently it does not fulfil its function and its use is not offered. The aqueduct in Jevíčko was removed. An aqueduct across nameless watercourse in 2017 is shown in Figure 4 on the right.

Figure 4 A setting device at none exist drive in 2017 (on the left), Example of a drain in 2017 (in the middle), An aqueduct across nameless watercourse in 2017 (on the right)

5 – Flooding drives

Drives were connected to a flooded property and brought water from streams to irrigated meadows. The drives have a trapezoidal shape with a sloping slope of 1:2 in cross-section to ensure easy maintenance. In the area of Malá Haná, the flood irrigation did not work well and surface watering was the main type of irrigation. The water flowing from the meadows was drained through the wastewaters back into the watercourse. Wastewater also served as drainage at higher blurring of the meadows. Care was taken to ensure that the meadows were not unnecessarily dry. An irrigation millrace with a floodgate in 1933 is shown in Figure 5 on the left.

Drives are mostly covered today. In the area of interest, part of one of them is located in the area below the Smolenská reservoir and in the area above the high. The drive, which enters the area of interest on the southern edge of Jevíčko, is currently part of drainage from the 70s of the 20th century.

Due to the predominant filling of the drives it is not possible to use them. Drills that have not been covered are currently part of a drainage whose functionality needs to be verified.

Figure 5 An irrigation millrace with a floodgate in 1933 (on the left), Damming along the Malonínský brook near Jevíčko in 2017 (on the right)

6 – Damming of flooded soil blocks

Around of the town of Jevíčko there is preserved flowing, which also belonged to the irrigation system. Damming was used to retain the excess water or settling of sediments.

Nowadays, the fence along the Malonínský brook is located close to its confluence with Jevíčka. At present, fencing is counterproductive, because in the case of smaller floods, the water cannot be poured out of the water into the surrounding fields. Damming along the Malonínský brook near Jevíčko in 2017 is shown in Figure 5 on the right.

However, with a higher flood flow, flood overflows may occur and the property is at risk. The drainage and permeable objects of the irrigation system in the dykes are already dilapidated and inoperative. Consequently, the remainder of the irrigation system cannot be considered as an effective flood protection measure.

CONCLUSION

Burton (2010) argues that the irrigation area worldwide has increased threefold over the last 50 years, from 94 million ha in 1950 to over 287 million ha in 2007. According to Čermáková and Mácová (2017) the total irrigated area in the Czech Republic increased from 17 113 hectares in 2015 to 25 003 hectares in 2016. In 2016 Czech agricultural holdings used mostly sprinkler irrigation (702 subjects), then micro-irrigation (382 subjects), surface irrigation (flooding, furrows) (72 subject) and 73 subjects exploited different irrigation methods. According to statistics provided by the Czech Statistical Office, it is evident that the current trend in irrigation of agricultural land in the Czech Republic is increasing in the long run. Today's spraying irrigation will be appropriate in the future to upgrade to more efficient irrigation techniques. Due to the current problems of drought, it will be advisable to carry out a thorough passportization of persistent irrigation systems and assess their usability for future use and incorporation into any of the planned irrigation systems. This will reduce the financial cost of building new systems.

For the area of interest, part of the area around the Malonínský brook near Jevíčko was selected. A survey of the surviving documentation was carried out and a survey of the terrain and the search for the existing irrigation system objects. A sophisticated irrigation system of the 1930s was used in the vicinity of Jevíčko (Coufal 1935). The irrigation was used to irrigate the meadows in the Malonínský stream floodplain and the Jevíčka stream. Fodder was used as a feed for livestock. In the post-war period, the irrigation was dropped and the irrigation channels were partly covered. After the Second World War, the grassland was largely converted to arable land and some soil blocks were drained. The conversion to the arable land in the Malonínský stream floodplain has brought negative consequences in the form of arable land ablation. This is currently visible in the Smolensk reservoir, where the sediment accumulates. Elements of the original surface watering irrigation system are still visible around the Malonínský stream. At present, it would probably not be profitable to restore this type of irrigation, but if it is needed, it will be useful to use its elements for a more modern way of irrigation. This will make it possible to use the Smolenská reservoir, which is currently the best preserved part of the original system. After measures to prevent settling of the sediment in the reservoir and its removal, the capacity of the reservoir will increase and hence this higher capacity will also be used for the supply of any irrigation system.

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