STUDIES REGARDING THE IRRIGATION SYSTEM FROM THE GREAT BRĂILA ISLAND – ROMANIA

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Abstract. *A significant part of the agricultural area of the Romanian state faces the negative effects of drought, insufficient water reserves and poorly functioning, deficient irrigation systems. The absence or degree of degradation of irrigation infrastructure has caused about 48% of the total agricultural area (7.1 million in 2019) to be affected by these unfortunate phenomena. The most affected areas were the Romanian Plain, Southern Moldova and Dobrogea). Adapting agriculture to climate change, adapting the food production system and reducing its effects on agricultural production, mainly but also on other components of the environment and population, involves the rehabilitation of existing irrigation infrastructure and, in particular, the construction of new irrigation systems. The aim of the paper is to identify the most suitable solutions for the rehabilitation and modernization of the irrigation infrastructure, as a whole. For this, the refurbishment works done in the plot number 37 owned by the Irrigation Water Users Association from the Great Braila Island, have been inventoried. Based on these observations and measurements, the behavior of the exploitation and the technical and economic efficiency of irrigation and the recommendation of rehabilitation solutions for arrangements in areas with similar characteristics of the framework and socio-economic characteristics.*

Keywords*: climate change, drought, irrigation system restoration*

INTRODUCTION

The high degree of degradation of the irrigation infrastructure meant that approximately 48% of the total agricultural area of Romania (7.1 million ha, in 2009) was affected by these phenomena (the most affected areas were the Romanian Plain, southern Moldova and Dobrogea) (VIȘINESCU, I. 2001).

Absolutely necessary, in the current climatic conditions of the Great Island of Brăila, irrigation has the disadvantage of being very expensive requiring high energy consumption, which is why the irrigated area has gradually decreased from 97% in 1978 to 21.5% (15 450 ha) in 1994 (RADU, O.,2017).

Over time, the systems deteriorated: cracks appeared on 60-70% of the supply channels, the hydrants deteriorated and a series of problems appeared in the network of buried pipes. In addition, the canals have been clogged for the most part and there is no monitoring of the distribution of water consumption. For these reasons, significant water losses occur (the efficiency of the arrangement is below 65-70%) leading to the lifting and mineralization of groundwater and to the salinization of soils (JITĂREANU,G., RĂUS,L., 2007).

The objective of the paper is to analyze the technical solutions for the rehabilitation of irrigation systems applied in the Big Island of Brăila in recent years.

MATERIAL AND METHOD

The Big Island of Brăila, the largest natural unit in the Lower Danube Meadow (figure 1), is the meadow part of the Danube between the main arms of the Danube (Navigable Danube and Măcin), starting downstream from the Gâsca island, near Hârsova , km 243) to Brăila (km 175).

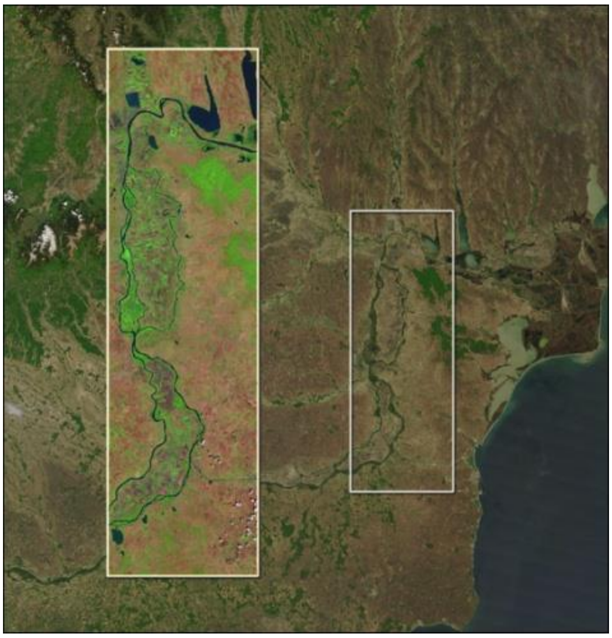


Fig. 1 Big Island of Brăila (satellite image Modis Aster)

Within Romania, the Big Island of Brăila is located in the southeast, being the administrative part of Brăila County (figure 2).

Fig. 2 The Big Island of Brăila, geographical location

Within the county, the Great Island of Brăila is located in the eastern part (figure 3), being comprised between the following coordinates:

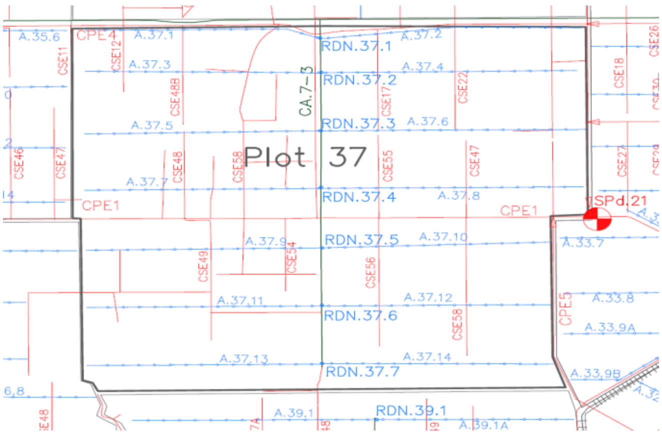
• 44^0 44 'and 45^0 30' latitude N

• $27^{0}04$ ’and $28^{0}10$’ length E

Fig. 3 The Big Island of Brăila within Brăila County

Research area

Plot number 37 (figure 4), represents the surface served by a pressure pumping station, owned by the Organization of Irrigation Water Users from the Island of Brăila.



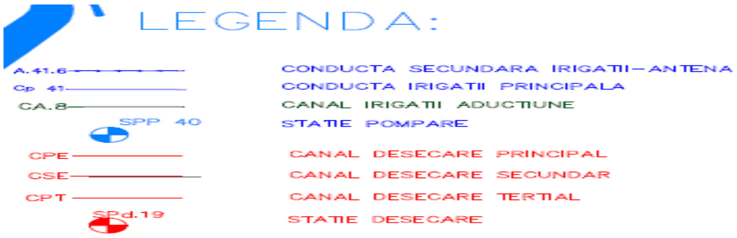


Fig. 4 Hydrotechnical scheme of the Plot arrangement 37

Irrigation plot number 37 is located on the territory of Frecăței commune and serves an area of 1920 ha in the farms - Țăcău, Frecăţei, Vulturu and Băndoiu.

From a climatic point of view, the area where the Great Island of Brăila is located, is part of a dry steppe climate, with hot dry summers and cold winters, low rainfall with long periods of drought, sometimes over 30 days, in the interval April-September, with temperatures above 22ºC in July, with maximum precipitation at the end of spring and minimum precipitation during winter. The average annual temperature is between 0 and 11ºC.

The coldest month is January (the average monthly temperature is between -2 and -5ºC), and the warmest period is in July-August, the average regularly exceeding 25ºC. The estimated frost depth according to STAS 6054/1977 is 90 cm from the soil surface. The aridity index is 22.

In the sector of the Big Island of Brăila, there are climatic influences of the climatic province of transition from the Mediterranean to the continental one, with mild winters and warm summers. In general, the climate is continental, with an island intercalation of a meadow and pond climate.

Precipitation is quite low, so that the annual average is below 450 mm and their distribution is quite uneven, long periods of drought that can exceed 30 days, occur in late spring and early autumn.

Precipitation falls mainly in windy periods (75%), in calm periods only 25% of precipitation falls.

The potential evapotranspiration has values up to 700 mm and exceeds on average by 200-300 mm annually the size of precipitation, indicating a deficient water regime.

Early frosts appear in late September, often in October, and the latest are in April and even May.

The wind has a frequency of 75% of the days of the year, and in 25% there are calm days.

Hot and dry winds often exacerbate aridity during the summer by diminishing crop production. In summer, the Austrian blows, a warm wind that brings drought.

The need for irrigation is indisputable, given that in all months of the vegetation period registers a deficit of humidity, culminating with the months of July and August, when critical phases are registered at most of the crop plants.

Pipeline network and plot pumping stations 37

a) The existing situation before rehabilitation

The interior irrigation arrangement of plot 37 consists of pressure stations. The pressurization stations take water from the CA7-3 supply channel, which is fed through the CA7 channel from the SPR Titcov Dig pumping station, located on the left bank of the Măcin arm (Old Danube).

The irrigation arrangement of plot 37 serves an important arable land of the farms 23 Ţăcău, 24 Frecaţei, 25 Vulturul and 26 Băndoiu.

Plot 37 has a gross area of 1920 ha and a net irrigable area of 1710 ha.

The pipeline network is located on a gross area of 1920 ha, being fed from the Danube River, through the SPR Titcov Dig pumping station, located on the left bank of the Macin arm (Old Danube).

The existing network of buried pipes, which constitutes the antenna network of plot 37, comprises 31,737 km of asbestos-cement pipes with diameters of 125, 150, 200, 250 and 300 mm.

The network of buried pipes consists of 14 antennas: A1, A1a, A2, A2a, A3, A3a, A4, A4a, A5, A5a, A6, A6a, A7, A7a, provided with 455 hydrants Dn 100 mm.

The antennas are located at distances of approx. 650 m from each other.

All antennas have the possibility to be alternately supplied from the pumping station to which they are connected. Hydrants are placed on the antennas at intervals of 72 m from each other, except for the hydrant at the upstream end which is located 36 m from the end of the antenna.

The plot is designed for the sprinkler watering method, initially dimensioned for the use of IIAM-17 sprinkler irrigation systems, which had 17 sprinklers. The functionality for the batteries of two installations was taken into account, the sizing being done at the flow rates necessary for them.

The network of buried pipes suffered damage consisting mainly of breaking, tearing and decommissioning of all hydrants.

In all the existing hydrants, the rupture of the hydrants itself was found, and in some hydrants, the upper branch of the underground roofs was also damaged.

The research method is similar to that of technical expertise for irrigation systems.

The field research analyzed the rehabilitation of the components of the irrigation system from Plot number 37, in order to recommend the rehabilitation solutions for arrangements in areas with similar characteristics of the framework and socio-economic characteristics.

RESULTS AND DISCUSSIONS

Rehabilitation works on the network of pipes and hydrants took into account:

- restoring the functionality of the existing antennas by restoring the pipe sections in the area of the broken hydrants (photo 1);

Photo 1 Hydrant network

- achieving the conditions for the use of modern irrigation equipment provided by OUAI IMB (Organization of Individual Water Users from the Big Island of Brăila) for drum and hose irrigation installations, respectively for central pivot irrigation installations (photo 2).

Photo 2 Irrigation system with drum and hose.

Regarding the rehabilitation of the pipeline and hydrant network, the following works were carried out:

New Dn hydrants (nominal size) 100 mm were purchased and used for irrigation water supply of drum and hose sprinkler irrigation systems.

The new hydrants were mounted as follows:

- new hydrants Dn 100 mm on existing pipes 175 pcs.

- 6 pcs. on asbestos-cement pipe Dn 300 mm;
-59 pcs. on asbestos-cement pipe Dn 250 mm;
-37 pcs. on asbestos-cement pipe Dn 200 mm;
-59 pcs. on asbestos-cement pipe Dn 150 mm;
-14 pcs. on the asbestos-cement pipe Dn 125 mm.

- new hydrants Dn 100 mm on pipes

PEID (high density polyethylene) 9 pcs.
- 4 pcs. on PEID pipe Dn 280 mm;
- 3 pcs. on PEID pipe Dn 225 mm;
- 2 pcs. on the PEID pipe. Dn 160 mm.

The hydrants have a flange connection made of high density polyethylene. Below you is a concrete slab on a 10 cm layer of sand. thickness. The joint is sealed using wide tolerance couplings. The upper part of the hydrant is made of a connecting element with two flanges and a hydrant valve.

The connection of the projected hydrants to the underground pipe will be made through a reduced tee with flange and two wide tolerance sleeves.

To protect the hydrants from breakage caused by the agricultural machinery, protective signals are placed at a short distance from them, without disturbing their normal handling and operation.

- New hydrants Dn 150 mm, in number of 45 pcs. were used to supply central pivot irrigation systems.

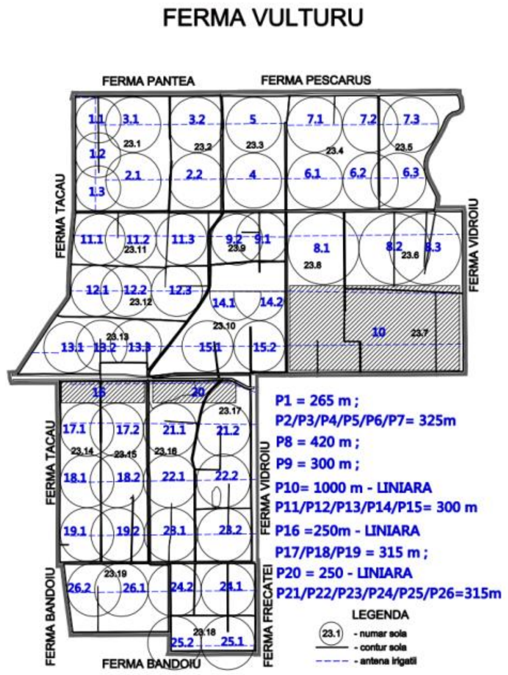


Photo 3 Pivot layout, Vulturu Farm

At the Vulturu farm, an area of 200 ha is irrigated with a linear installation of 1000 m, supplied with water from the canal, with the help of a floating pontoon (photo 4).

Photo 4 Linear irrigation system with floating pontoon

Hydrants are located as follows:

• 41 hydrants on the existing asbestos-cement pipes, of which:

-22 pcs. on asbestos-cement pipe Dn 250 mm;

-10 pcs. on asbestos-cement pipe Dn 200 mm;

-8 pcs. on asbestos-cement pipe Dn 150 mm;

-1 pc. on asbestos-cement pipe Dn 125 mm.

• 4 hydrants on the A7 pipeline, HDPE, of which:

- 2 pcs. on HDPE pipe Dn 280 mm;
- 1 -pcs. on HDPE pipe Dn 225 mm;
- 1 pc. PEID pipeline Dn 160 mm.

The pivots are anchored in simple concrete anchoring masses, which gives them a proper stability in operation (photo 5).

Photo 5 Pivot irrigation system connected to hydrant

The connection of the hydrants mounted to the underground pipe was made by means of a reduced tee with flange and two wide tolerance sleeves.

To protect the hydrants from breakage caused by the agricultural machine, protective signals are placed at a short distance from them, without disturbing their normal handling and operation.

Restoration of pipe sections with broken hydrants 241 pieces of which 161 rebuilt by replacement with HDPE nozzles and 80 pieces. by plugging with blind flange.

The refurbishment works provided for the pipeline and hydrant network consisted of:

- restoration of the existing pipe sections where the existing hydrants were broken;
- installation of new hydrants, as well as restoration of the pipe sections for the other broken hydrants (241 pcs.), as follows:

• 161 pcs. remade by replacement with PEID nozzles and
• 80 pcs. remade by blind flange plugging.

The restoration of the sections from the existing pipeline where the existing hydrants were broken (241 pcs.) Was performed through two types of works:

a) dismantling the existing broken tees and replacing them with 60 cm long PEID nozzles connected to the existing pipes (total 161 pcs.), of which:

-2 pcs. on asbestos-cement pipe Dn 300 mm;
-93 pcs. on the asbestos-cement pipe Dn 250.mm;
-44 pcs. on asbestos-cement pipe Dn 200 mm;
-18 pcs. on asbestos-cement pipe Dn 150 mm;
-4 pcs. on asbestos-cement pipe Dn 125 mm.

b) mounting of blind flanges on undamaged tees, 80 pcs., of which:

- 1 pc. on asbestos-cement pipe Dn 300 mm;
- 44 pcs. on asbestos-cement pipe Dn 250 mm;
-21 pcs. on asbestos-cement pipe Dn 200 mm;
-14 pcs. on asbestos-cement pipe Dn 150 mm;

In plot 37, 7 new pumping stations were purchased, namely SP37.1, SP 37.2, SP 37.3, SP 37.4, SP 37.5, SP 37.6 and SP 37.7

Irrigation of the surface of plot 37 is done by running 7 pumping stations that serve this plot, on the site of the former pumping stations.

Irrigation of the surface of plot 37 is done by running 7 pumping stations that serve this plot, on the site of the former pumping stations. Compared to the existing situation, there were differences in parameters due to use other types of watering installations, of modern type, which require different flow and pressure values than those taken into account at the time of the arrangement.

The use of the same type of irrigation system (for the whole plot) led to the equipment of all stations with submersible electric pumps with identical characteristics:

- Qp = 80 L/s Hp = 70 mCA, P = 115 kW.

States SP37.2 + SP37.7 were each equipped with two self-coupling submersible electric pumps, having the following characteristics:

- Qpompa= 80 L/s, Hp = 70 Mca

The SP37.1 station will be equipped only with an electric pump, having the following characteristics:

- Qpompa = 80 L/s, Hp = 70 mCA

Realization of constructions

On the site of each station, before the start of the works, the existing 2.0x1.0x1.0 m concrete pedestals were demolished, as well as the 1.0x1.0x0.65 m anchoring massifs.

The solution adopted for the stations is of reinforced concrete tank type with dimensions in plan, inside 3.20 x 2.30 m, except for the tank of station sp 37.1, which has dimensions in plan inside 3.20 x 1.40 m. The walls are 25 cm thick, the screed has 30 cm thick.

The depth of the station tanks was established so that the electric pumps were provided with drowning compared to the minimum water level in the AC 7-3 supply channel.

- SP 37.1 - h=2.50 m.
- SP 37.2 - h=3.00 m.
- SP 37.3, 37.4 si SP 37.5 - h=2.50 m.
- SP 37.6 - h=3.30 m.
- SP 37.7 - h=3.50 m.

A 10 cm thick layer of C810 leveling concrete was provided under the screed.

Peste stratul de egalizare s-a turnat radierul cuvei.

Groundwater depletion was done with the motor pump on the tractor during the pouring of the concrete.

The positioning of the gaps were made according to the plans of hydromechanical installations, the passage parts will be of tight type.

At the top, a floor 15 cm thick was provided, in which the holes necessary for mounting the pumps were drilled, as well as the access gap.

For access to the tank, a frame with a lid fixed in the concrete slab was provided by means of rods welded by it (photo 6).

Photo 6 Realization of the annex constructions for concrete tank type stations

The filling works were carried out in layers of 10-12 cm with the compaction of each layer.

The canal was protected in the suction area with a simple concrete wall 10 cm thick, 3.00 m upstream and 3.00 m downstream of the suction pipes. The pier was made on the side of the station, as well as on the bottom of the canal and on the opposite slope, up to the upper level of the water in the canal (photo 7).

Photo 7 Protecting the canal in the suction area

In order to anchor the discharge pipe, four anchoring masses were provided at each station.

In order to support the discharge pipe at the crossing of the canal, two reinforced concrete pillars were provided to support it. The pillars have a section of 30x30 cm and are embedded in foundations of 60x60 cm, laid at the depth of frost in the area (approx. 1.00 m), photo 8.

Photo 8 Crossing the pipe to the antenna

Automation installation

The programmable controller mounted in the panel provides two operating modes: "manual" mode (local) used for testing, commissioning and starting of the pumps in the absence of communication and an "automatic" (distance).

In "automatic" mode1 the pumps start / stop depending on the pressure necessary for the operation of the pivots in operation.

To ensure the pressure the flow required by the pivots, the converter adjusts the operating speed of the pump and the other will be switched off or will operate at rated speed (connected to the mains).

The pumps are protected from running without water by placing a minimum level sensor in the tank that will automatically stop the pumps from running.

The display of the panel shows the status of the pumps (on / off / failure), all their operating parameters, the number of operating pivots on each antenna, the operating time and the pumped water flow (photo 9).

Photo 9 Pump control panel display

CONCLUSIONS

By modernizing and refurbishing the interior irrigation system, in order to supply water to the new central pivot type installations and with drum and hose through which water is distributed to the plants, the number of hydrants has been reduced from 455 (initially provided on the antenna network) , at 226 pcs, of which 184 pcs. having Dn (nominal size) 100 mm and 45 pcs. having Dn 150 mm.

1. Rehabilitation of irrigation systems led to:

- capitalizing at a higher level on the agro-productive potential of the areas served;
- ensuring safe and high yielding agricultural production;
- reducing the negative effects of some limiting environmental factors (prolonged droughts, combating soil erosion);
- improving the microclimate, by avoiding soil degradation and supporting the growth of vegetation in the area.

2. The rehabilitation of the main irrigation infrastructure in these facilities has led to the achievement of savings in water and energy resources, by reducing losses and applying efficient resource management.

3. It is estimated that from the point of view of environmental protection, the rehabilitation of irrigation infrastructure has had a favorable impact on the related areas, contributing to the conservation of their biodiversity and the formation of new biotopes.

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