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SUSTAINABLE WATER MANAGEMENT THROUGH THE REHABILITATION AND MODERNIZATION OF THE SECONDARY IRRIGATION INFRASTRUCTURE IN THE ARRANGEMENT OF OUAI FÂNTÂNELE, ARAD COUNTY

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Abstract: *Climate change is increasing the frequency of droughts and rainfall deficits, so rehabilitating degraded irrigation schemes has become essential for reducing water losses and pumping energy. This paper presents and verifies the engineering solution for modernizing the secondary irrigation infrastructure of the SPP Fântânele–Șagu plot (OUAI Arad Fântânele, 1857 ha net), supplied from the Mureș River. The study analyses the crop water requirements, establishes the irrigation regime and design flow, and verifies the hydraulic sizing of the new buried PE100 pipe network. The solution reduces water losses by 58–61% and pumping energy by 36–48%, supporting a resilient, high-performance agriculture in the Western Plain.*

Keywords: *irrigation rehabilitation, buried pressure pipe network, irrigation regime, water losses, pumping energy efficiency*

• Introduction

Drought is a major climatic risk in south-eastern Europe, and repeated summer rainfall deficits in western Romania make field-crop yields increasingly dependent on irrigation [1–3]. Most Romanian irrigation schemes date from 1965–1990 and have exceeded their service life. Their secondary infrastructure, managed by Water Users Organizations (OUAI), is modernized through the National Strategic Plan 2023–2027, which requires a reduction of water losses.

Aim: to verify the rehabilitation solution for the SPP Fântânele–Șagu plot (OUAI Arad Fântânele): irrigation regime and design flow, hydraulic sizing of the new pipes, and the expected savings of water and pumping energy.

• Material and method

Study area. The plot lies on the left bank of the Mureș River, 10 km from Arad (net area 1857 ha; 10.8 °C and 577 mm mean annual temperature and precipitation). Water from the Mureș is lifted into the CA Fântânele canal and pumped by the SPP Fântânele–Șagu station into the buried network (Figure 1). Built in 1969–1970, the scheme has worn-out pumps (65% efficiency) and leaking asbestos-cement and

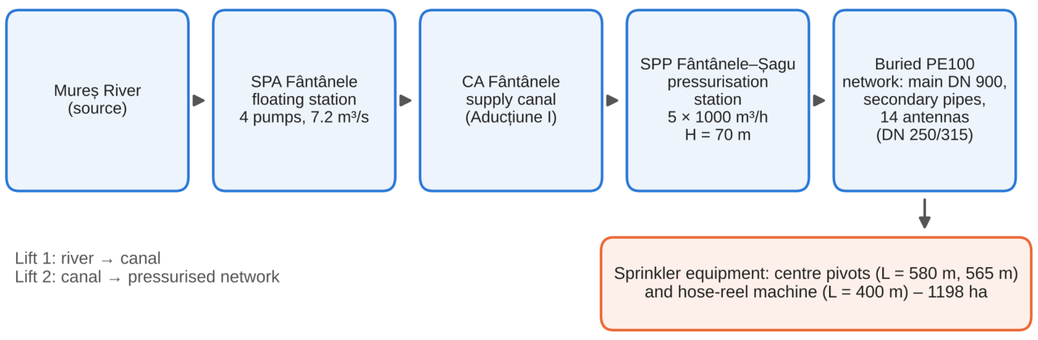


Figure 1. *Water supply chain of the SPP Fântânele–Șagu irrigation plot*

Data and calculations. Design documentation DALI no. 393/2023 [8], with the technical expertise and geotechnical and topographic surveys:

- irrigation regime at 80% probability: $q_n = m / (3.6 \cdot T \cdot t)$, $q_b = q_n / \eta_a$, $Q = q_b \cdot S$ [9];
- pipe sizing: $v = 4Q/(\pi D^2)$ and Darcy–Weisbach losses with the Swamee–Jain friction factor (PE100 SDR 17, k = 0.01 mm);
- pumping: $P = \rho g Q H / \eta_p$, $E_s = gH / (3.6 \cdot \eta_p)$;
- water balance: $V_s = V_n / (\eta_f \cdot \eta_c \cdot \eta_p)$, and conservatively with $\eta_p = 1$.

• Results and discussions

Irrigation regime. Wheat, sunflower and maize cover 75.9% of the 1198 ha irrigated in 2022–2023. With 400 m³/ha per application, four applications and 20 h/day, the net hydromodulus is 0.555 L/s/ha and the design flow 1.21 m³/s for 1857 ha. The new station (5 × 1000 m³/h, 70 m, 80% efficiency, frequency converters) delivers 1.39 m³/s, a 15% reserve.

Pipe network. The PE100 pipes (DN 900 main section and 14 antennas of DN 250/315, 3600 m) run at 1.24–2.81 m/s with friction losses of 0.7–6.2 m, well within the 70 m head and the 3–4 bar needed at the pivots.

Water, energy and cost. Water losses fall by 61.2% (58.1% conservative), pumping energy by 48.3% (36.3%) and the cost of water from

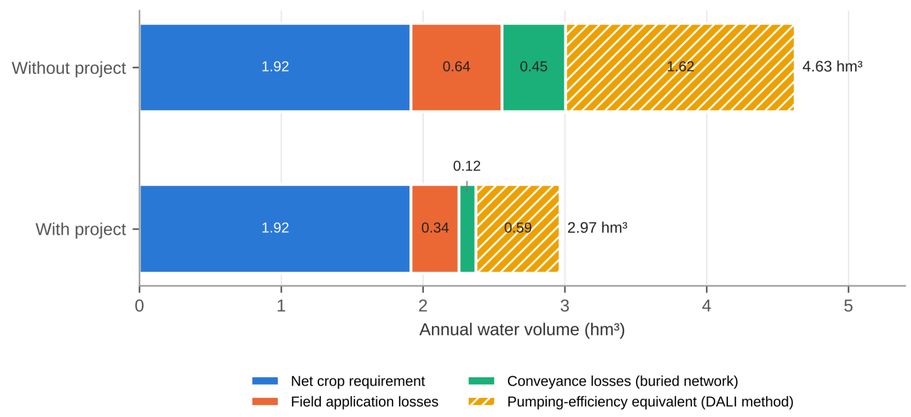


Figure 2. *Annual water balance without and with the project (1198 ha)*

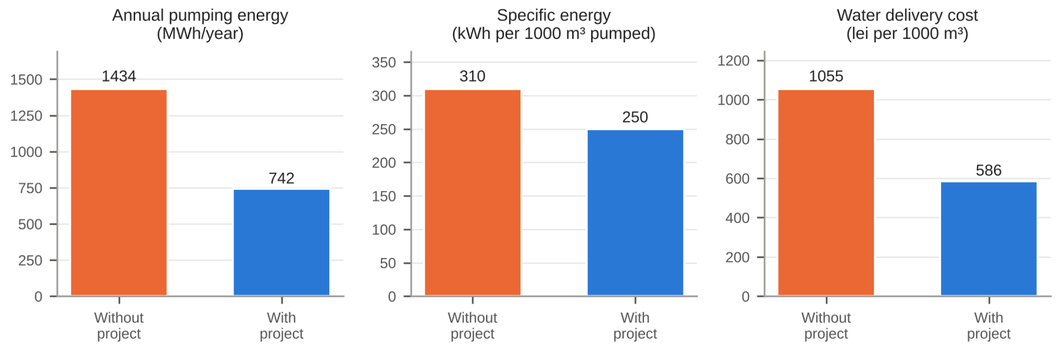


Figure 3. *Energy and cost indicators without and with the project*

• Conclusions

- The modernized station covers the full net area of 1857 ha with a reserve of about 15%.
- The new PE100 network is correctly sized for the 70 m head and the pivot pressure.
- Water losses are expected to fall by 58–61%, pumping energy by 36–48% and the cost of water by 44.5%, to be confirmed by measurements after commissioning.

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