

Project: “Monitoring Sea-water intrusion in coastal aquifers and Testing pilot projects for its mitigation” Interreg CBC Italy-Croatia 2014.-2020.

Priority Axis: Safety and resilience

Specific objective: Improve the climate change monitoring and planning of adaptation measures tackling specific effects, in the cooperation area

(D_3.3.2) Database on groundwater and surficial water level, temperature and electrical conductivity, meteo-climatic conditions, sea level, pumping station activity in the Croatian monitoring area

Work Package 3: Studying

Activity 3: Monitoring network

Partner in charge: PP4 (UNIST-FGAG)

Partners involved: PP4 (UNIST-FGAG), PP5 (CROATIAN WATERS), PP6 (DUNEA)

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Contents

Monitoring system in Neretva Valley and guidelines for using data sets in attachment	2
Attached data sets	8
List of figures.....	8

Monitoring system in Neretva Valley and guidelines for using data sets in attachment

Monitoring system of the piezometric states and salt water intrusion parameters has been established in 2009. During project MoST, improvements have been made by performing new gauges, installing new monitoring locations and enabling real time data acquisition.

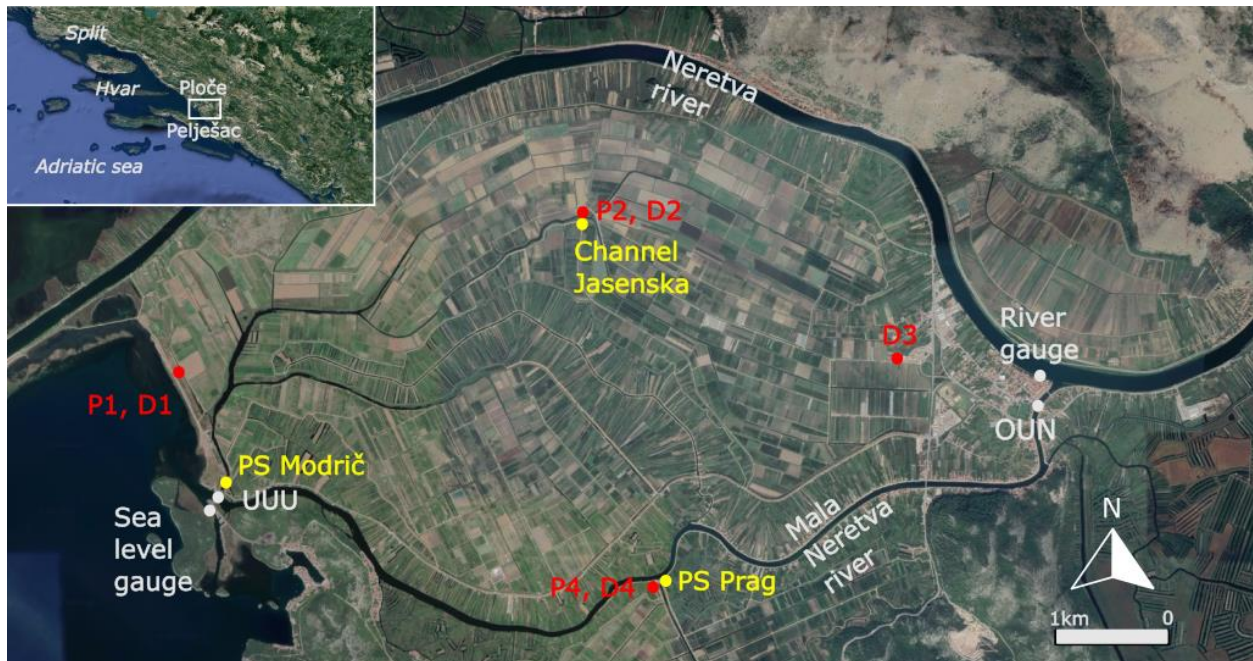


Figure 1 River Neretva Valley area of interest with locations of observation piezometers, surface water gauges.

Data sets from 2019 were acquired with existing monitoring system before the project MoST. A tide gauge station located close to the Mala Neretva mouth while Neretva surface elevation gauge has been located at the left side of Neretva river bed in Opuzen town. Two additional surface water elevation gauges are located at Mala Neretva river, one downstream from the gate in Opuzen, identified as OUN, and the other one, UUU, upstream from the gate at Mala Neretva mouth. All four type of stations are equipped with the instrument /shaft encoder THALIMEDES OTT with a sampling frequency of 1/hour, measuring range of ± 19.999 m, resolution of 0.001 m and accuracy of ± 0.002 m.

Electrical conductivity (EC), groundwater level (h) and temperature (T) in unconfined aquifer have been observed at three locations identified by P1, P2 and P4 on Figure 1. For h observations, OTT ORPHEUS MINI vented gauge has been used and set up to sampling frequency of 1/hour with measuring range from 0 to 40 m and resolution of 0.001 m. A MANTA 2 40+ gauge has been installed to observe groundwater EC and T in piezometers. This gauge has a measuring range of 0 to 100 mS cm⁻¹ with an accuracy of $\pm 1\%$ and 0.0001 mS cm⁻¹ resolution for the EC standardized to 25 °C. The T sensors range is -5 to 50 °C with resolution of 0.01 °C and an accuracy of ± 0.1 °C. Piezometers have been drilled and penetrated in unconfined aquifer with a finite depth of 10 m below the ground level with inner diameter of 12 cm. The height of perforated screen equals to 9.50 m starting from piezometers at bottom. Gauges have been installed 2.0 m above the piezometer bottom.

Within the piezometers marked with letter D, penetrated to deep, confined aquifer, TE Connectivity TRUBLUE vented gauges with a 0 to 300 psi range and accuracy of $\pm 0.05\%$ Total Error Band (TEB) have been installed to observe h values at three locations respectively D1, D2, and D4. For the D1 piezometer, overall piezometer depth was set up to 38.30 m, with a perforation height of 1.20 m within the confined aquifer, beneath the confining clay layer. Piezometer D2 overall depth equals to 30.80 m, with a perforation height of 3.0 m within the gravel media to ensure the insight to confined aquifer piezometric state. For the piezometer D4, the overall installation depth was set to 32.87 m, with a perforated depth of 2.0 m within the confined aquifer. The inner diameter of confined aquifer penetrating piezometers corresponds to 8.0 cm. The depth of gauges installation corresponds to 10 m below piezometers top.

Hourly values of barometric pressure, cumulative hourly precipitation, average hourly temperature and average hourly air humidity have been observed by local meteorological station Ploče operated by National HydroMeteorological Institute and they were provided by the same Institute.

Hourly values of discharge and temperature of river Neretva were observed near the city of Metković. Measuring station is operated by Croatian Waters.

In 2020, probes located in deep piezometers (D1, D2, D3 and D4) were replaced with The Manta2 +40 possess a range of 0-100 mS cm⁻¹ for EC and 0-50 °C for T with an accuracy of $\pm 1\%$ of reading for EC and the temperature of ± 0.1 °C with the exception of D1 piezometer. In D1 piezometer

TruBlue CTD 585 multiparameter probe with the ability to monitor groundwater level, EC, and T with accuracy of $\pm 0.05\%$ of the total error band for water level in the range of 0-10.5 m water column, accuracy of 1% or 0.02 mS cm⁻¹ for EC in the range of 0.005-100 mS cm⁻¹, and an accuracy of ± 0.2 °C for T in the range of 0-50 °C was installed. The EC reading in all probes is standardized to 25 °C.

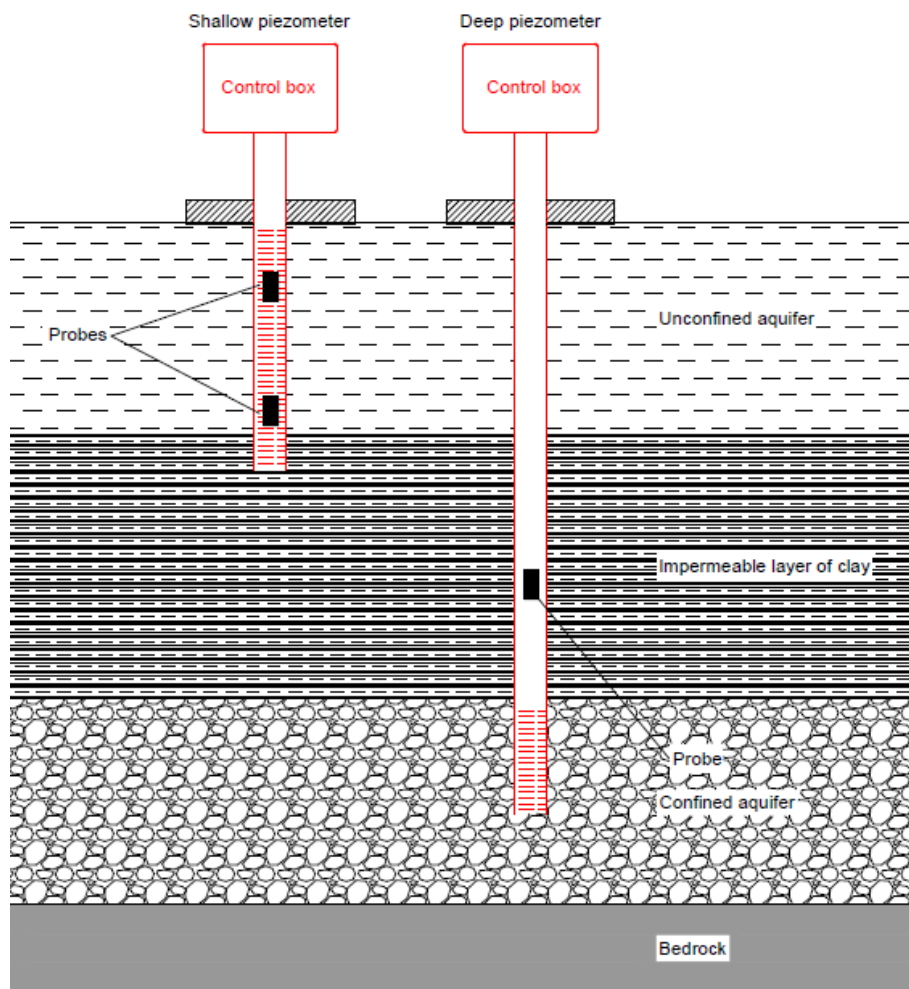


Figure 2 Piezometers schematic cross-section and the location of the probes after the improvement of the monitoring system that occurred in 2021.

The major improvement occurred in 2021. when multiple new gauges were installed. Three new monitoring locations were added to monitoring system and all three locations are monitoring surface water parameters, respectfully these locations are: i) Channel Jasenska, ii) PS Modrič intake basin and iii) PS Prag intake basin as can be seen in Figure 1. Hereby, same TrueBLue CTD 585 has been installed at these locations. In piezometers located in unconfined aquifer (P1, P2 and P4) one additional probe per piezometer is added on different depth for the purpose of multilevel monitoring of electrical conductivity and temperature in groundwater (Figure 2) The upper probe is marked with letter G in excel database (Data_2021) and the upper probe corresponds to TrueBlue CTD 585 multiparameter probe. The lower probe, marked with letter D in shallow piezometers is the Manta2 +40 with the ability to monitor EC and T. Exact vertical location of each probe in shallow aquifer can be seen in Figure 3.

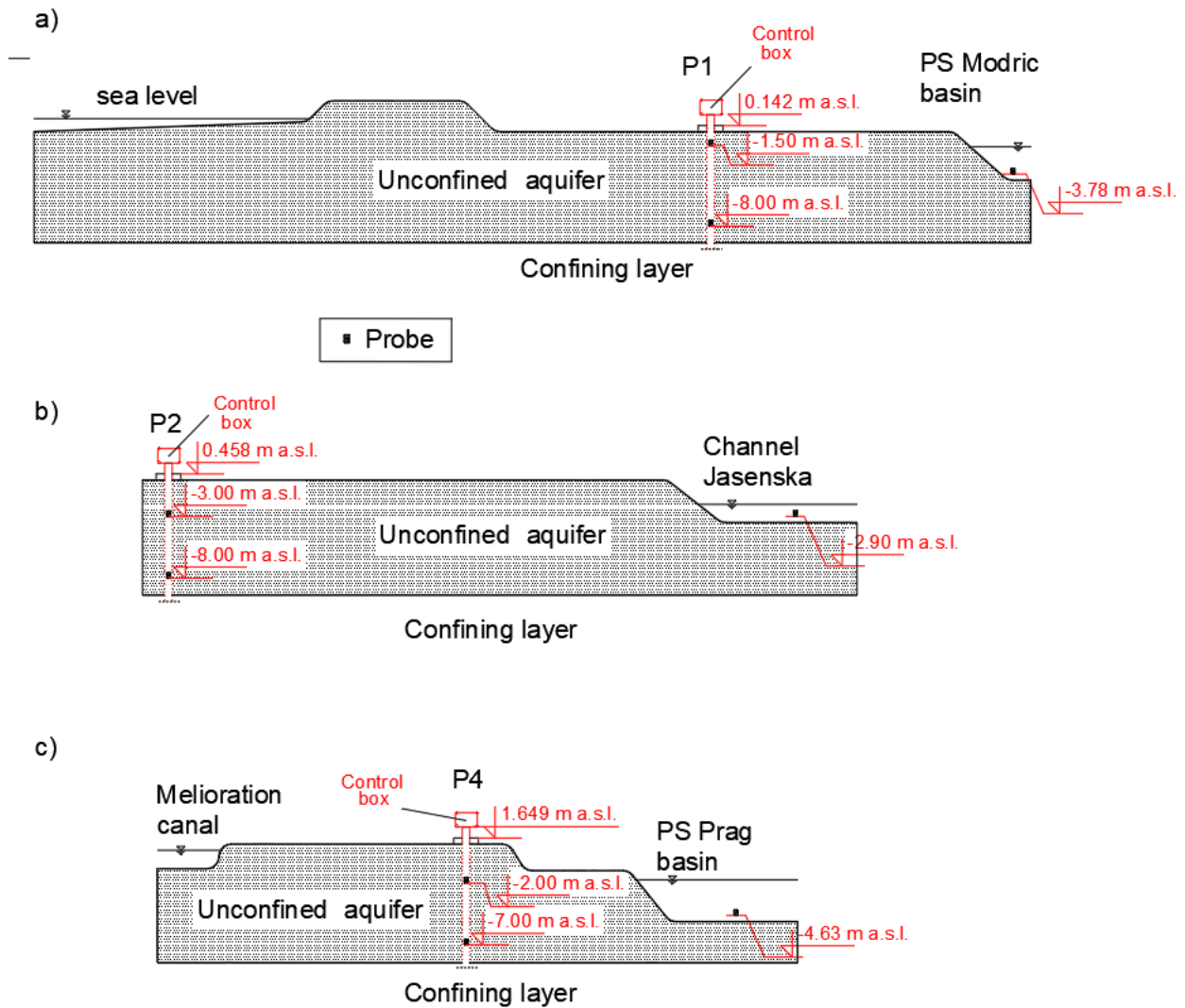


Figure 3 Cross section of (a) location P1 with depth position of probes, (b) location P2 with depth position of probes and (c) location P4 with depth position of probes.

All variables covered by the monitoring system have been temporarily synchronized while the reference vertical datum used for the height and depth elevation corresponds to "Nula Trsta".

Additionally, sampling frequency on all monitoring locations was changed from hourly to 15-30min sampling rate depending on the location. The sampling rate and data sets with new sampling rate can be seen in Excel file under the name Data_2021_2. In this file each excel sheet is named after the sampling rate.

It is important to explain that during the datasets period (2019-2021) there are several gaps in data sets. This gaps in data sets occur when probe or gauge is not working, usually due to maintenance or malfunction of probes.

The latest position of the probes, model of the probes and sampling rate of each can be seen in Table 1.

Table 1 Depth, model and sampling rate of each multiparameter probe in Neretva Valley monitoring system.

Location	Depth (m a.s.l.)	Probe model	Sampling rate
Channel Jasenska	-2,90	TrueBLue CTD 585	15min
PS Prag	-4,63	TrueBLue CTD 585	15min
PS Modrič	-3,78	TrueBLue CTD 585	15min
D1	-7,00	TrueBLue CTD 585	15min
D2	-7,00	Manta 2	30min
D3	-7,00	Manta 2	30min
D4	-7,00	Manta 2	30min
P1_G	-1,50	TrueBLue CTD 585	15min
P1_D	-8,00	Manta 2	15min
P2_G	-3,00	TrueBLue CTD 585	15min
P2_D	-8,00	Manta 2	30min
P4_G	-2,00	TrueBLue CTD 585	15min
P4_D	-7,00	Manta 2	30min

Attached data sets

1. Data_2019
2. Data_2020
3. Data_2021_1 (Data sets from January 1st 2021. – July 1st 2021.)
4. Data_2022_2 (Data sets from July 1st 2021. – January 1st 2022.)

List of figures

Figure 1 River Neretva Valley area of interest with locations of observation piezometers, surface water gauges.	2
Figure 2 Piezometers schematic cross-section and the location of the probes after the improvement of the monitoring system that occurred in 2021.	4
Figure 3 Cross section of (a) location P1 with depth position of probes, (b) location P2 with depth position of probes and (c) location P4 with depth position of probes.	6