University of Split
Faculty of Civil Engineering, Architecture and Geodesy

Monitoring the dynamic behavior of seawater intrusion in the Neretva Valley

Ivan Lovrinović

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Monitoring system:

- In order to understand dynamic nature of SWI, monitoring system in the Neretva Valley has been set up
- 4 surface gauges with hourly measurement of sea/water level elevation
- 3 surface gauges with hourly measurment of water level, electrical conducitivity (EC) and temperature (T)

Figure. Monitoring system in Neretva Valley

Monitoring system:

Monitoring system:

- 3 piezometers in confined aquifer (D1, D2 and D4)
- 3 piezometers in unconfined aquifer (P1, P2 and P4)

Figure. Monitoring system in Neretva Valley

Monitoring system:

- In each deep piezometer (D1, D2 and D4) in confined aquifer multiparameter probe is installed with hourly measurment of piezometer head, EC and T
- In each shallow piezometers in unconfined aquifer two multiparameter probes are installed with hourly measurment of piezometer head, EC and T

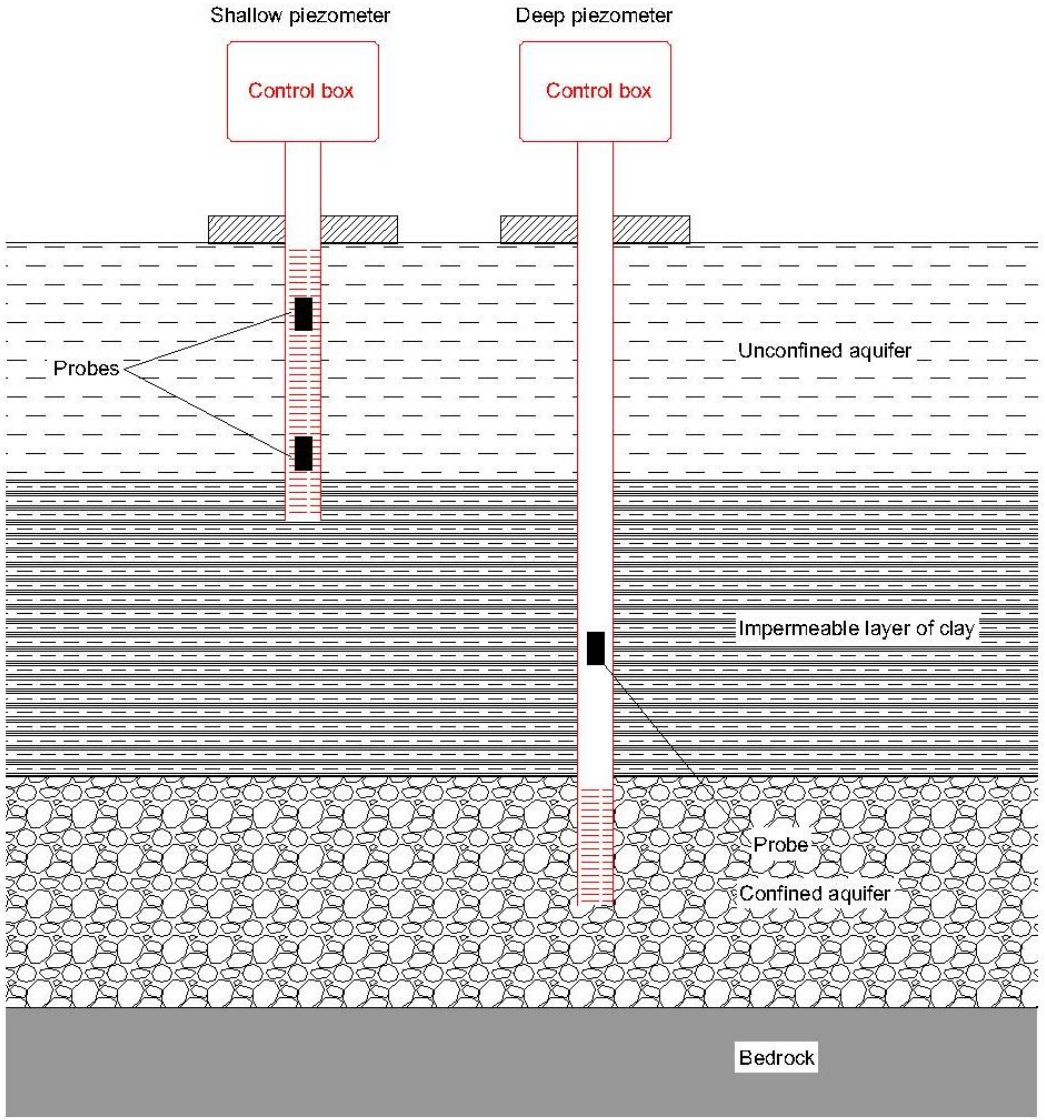


Figure. Piezometers cross section

Geological settings of Neretva Valley:

Based on the available data from previous geotechnical and geophysical investigation geological model of Neretva Valley has been set up.

- Sandy unconfined layer on the top with overall thickness of 1 to 10 [m]
- Second layer is confining layer of clay with thickness of 10 to 25 [m] that continues beneath the sea approximately 1400 [m] (Srzić et al. 2020)
- Gravely confined layer is beneath layer of clay with local presence of conglomerate
- Limestone bedrock on the bottom

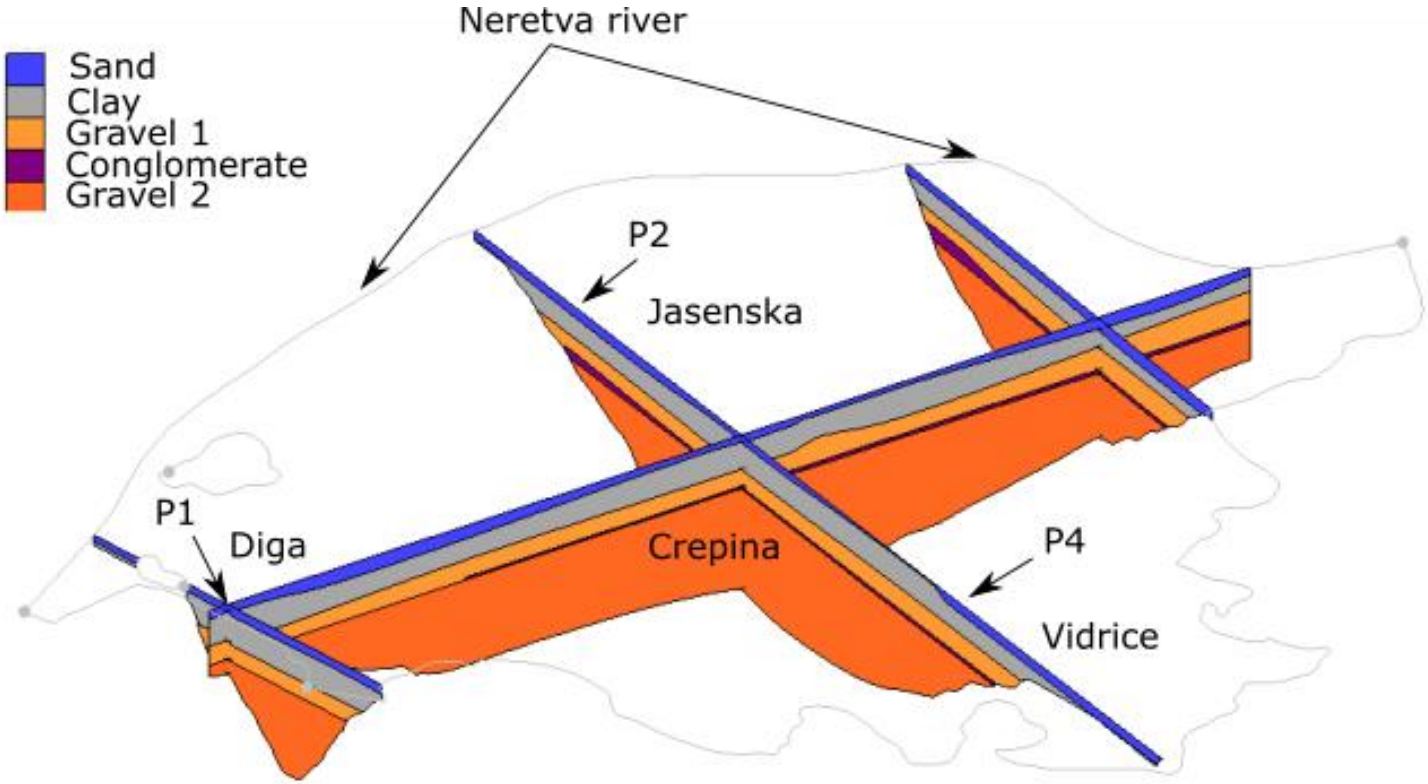


Figure. Geological model of Neretva Valley

Methodology:

FFT Coherence:

$$r = \frac{|G_{XY}|^2}{G_{XX}G_{YY}}$$

r – magnitude square coherence (coherence)
G_{XY} – cross power spectral density
G_{XX} and G_{YY} – power spectral density (PSD)

Wavelet Coherence:

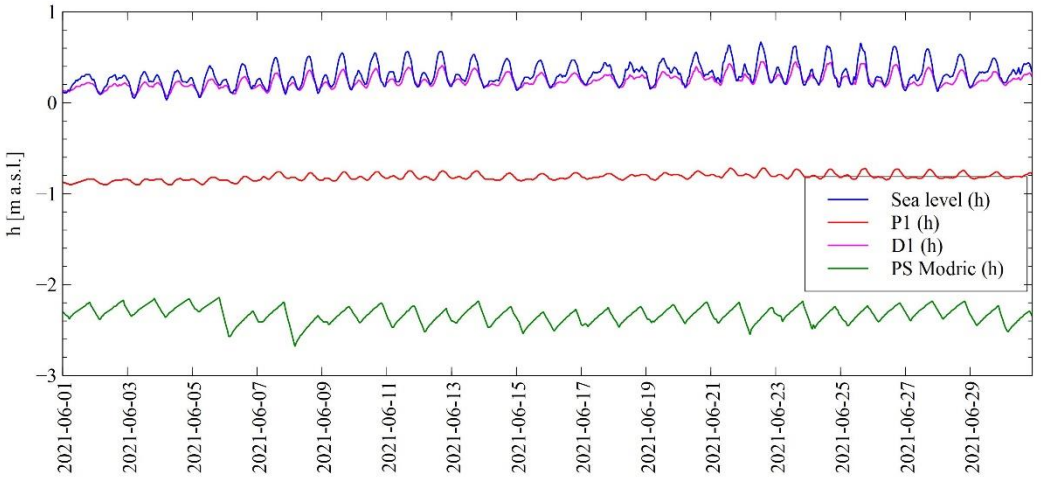
$$\mathrm{WTC} = \frac{|W_n^{XY}(s)|^2}{W_n^{xx}(s)W_n^{yy}(s)}$$

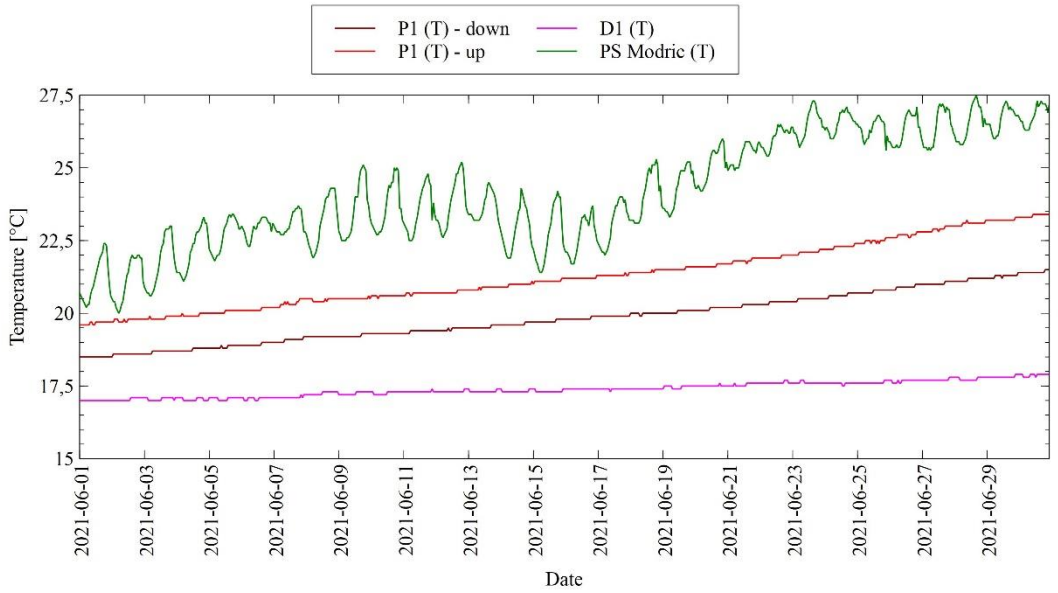
WTC – magnitude square coherence (coherence)
s – wavelet scale
W_{XY} – cross wavelet transform
W_{XX} and W_{YY} – wavelet power spectrum

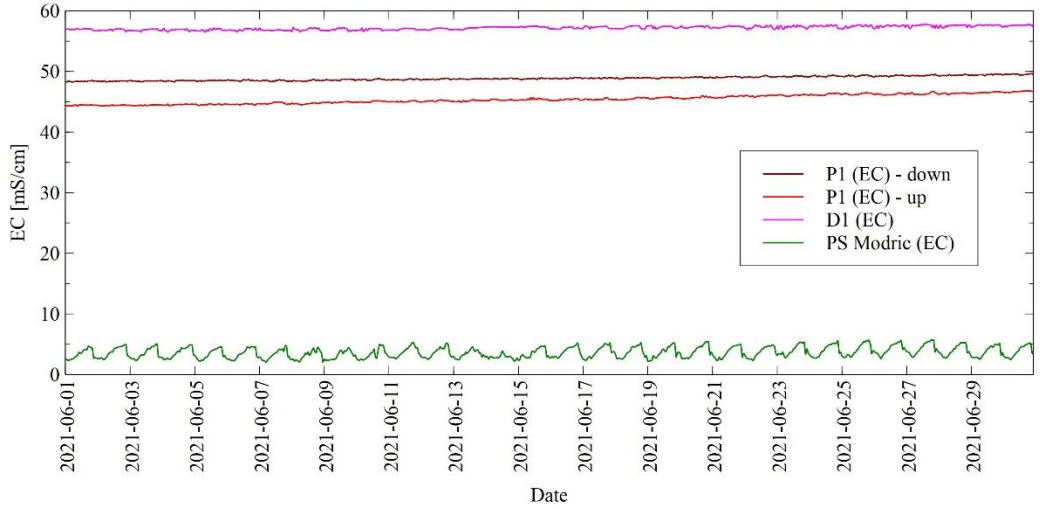
- Coherence represents functional linear dependancy between same frequencies of two signals as a function of phase shift.
- Coherence takes value from 0 to 1.
- Value of 0 means no coherence between frequencies and value of 1 represents total coherence

Results:
P1

- Observed signal of piezometric head in P1 corresponds to sea level with attenuation in amplitudes and lower mean value thus creating favourable conditions for active sea water intrusion



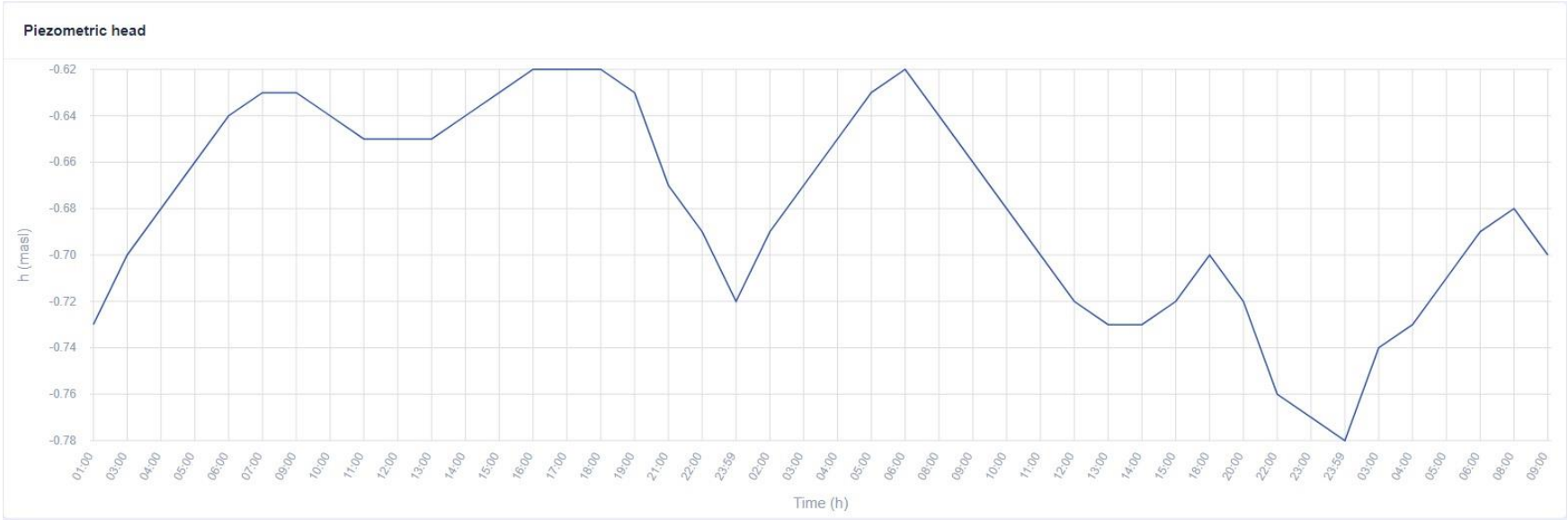




Results: P1

- Observed signal of piezometer head and EC in P1 in real time from *www.neretva.waveform.hr* (7.10.2021. – 9.10.2021.)

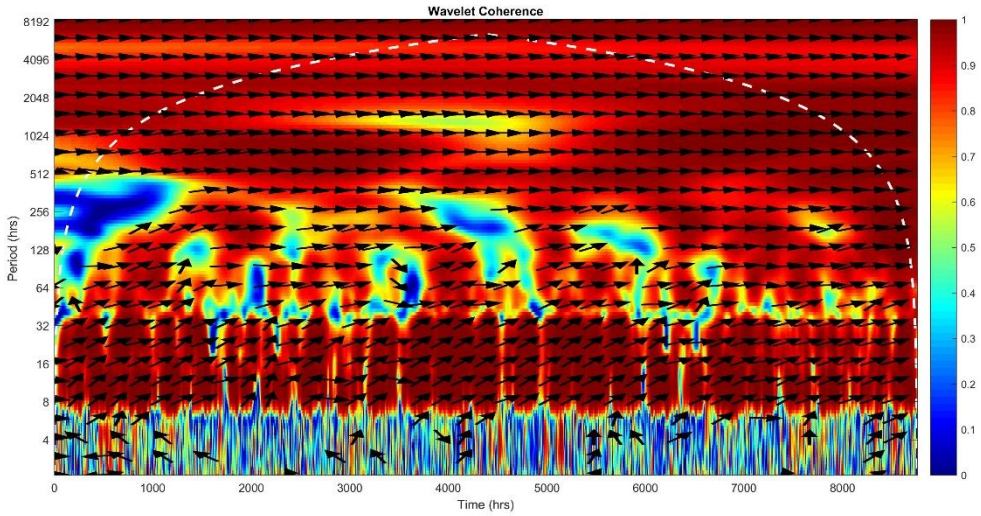
www.neretva.waveform.hr



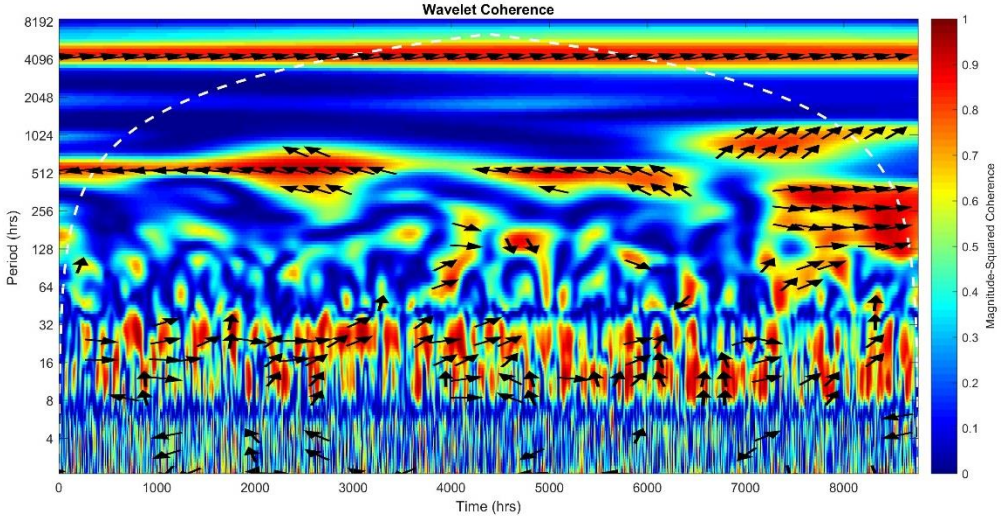
Results: P1

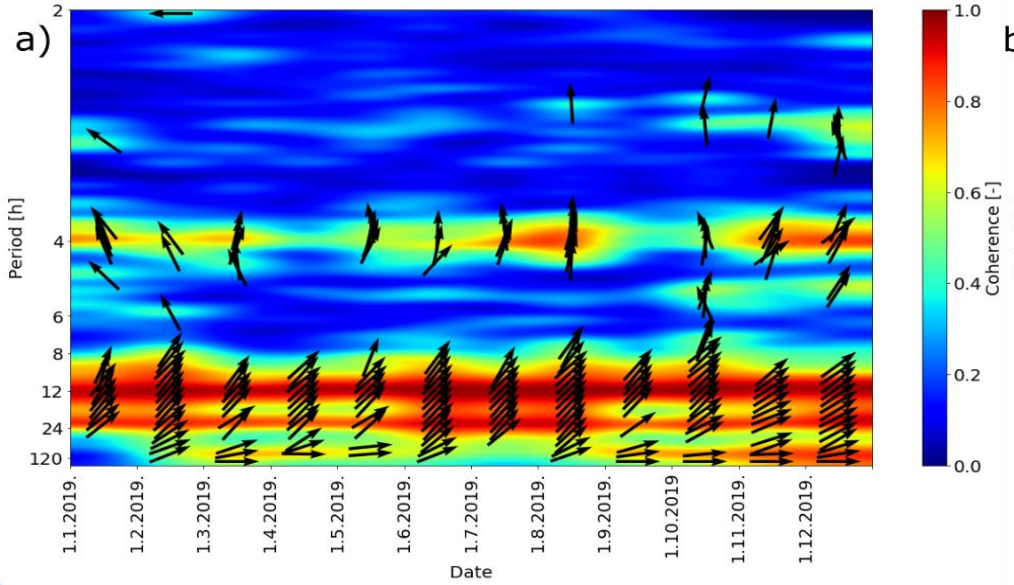
- On both coherence models between sea level and piezometric head in P1 it can be concluded that sea level is dominantly affecting piezometric head fluctuations
- EC in P1 shows only presence of diurnal and semidiurnal component from the tidal fluctuations

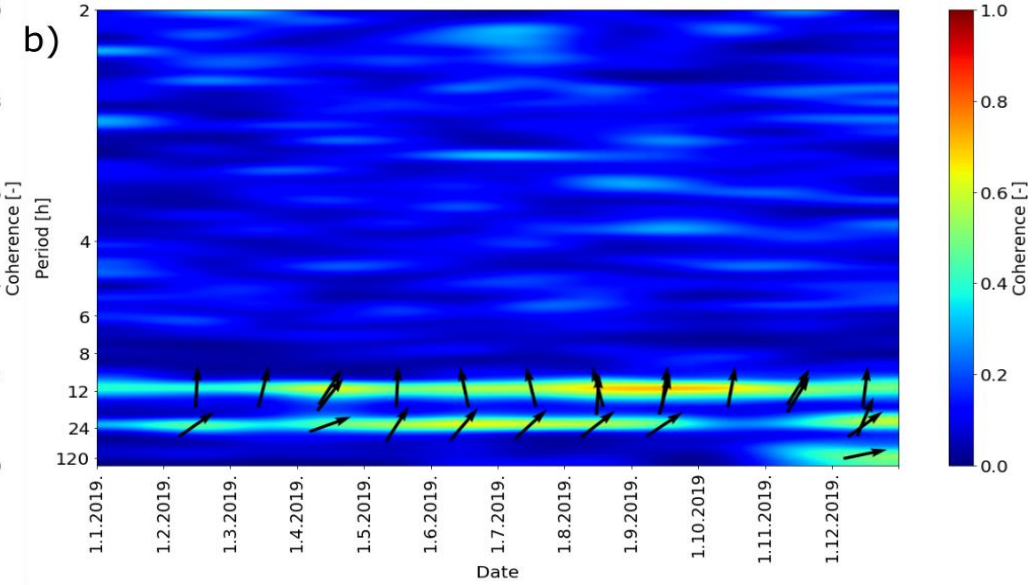
Sea level - P1



Sea level - P1 EC

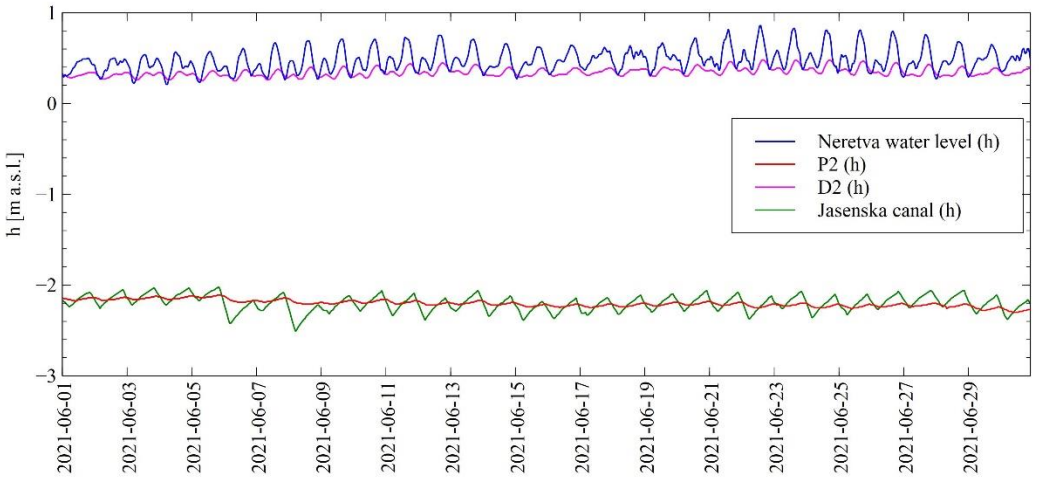


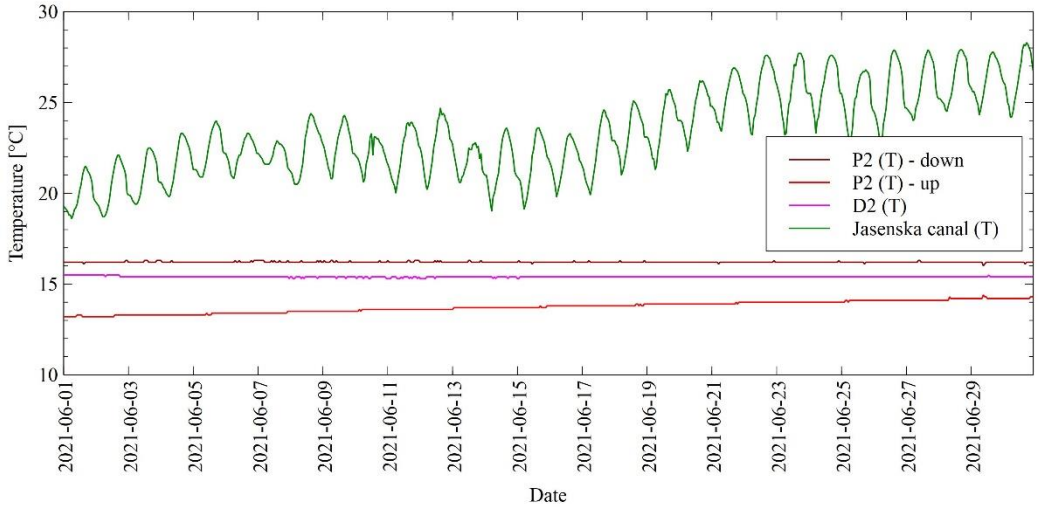


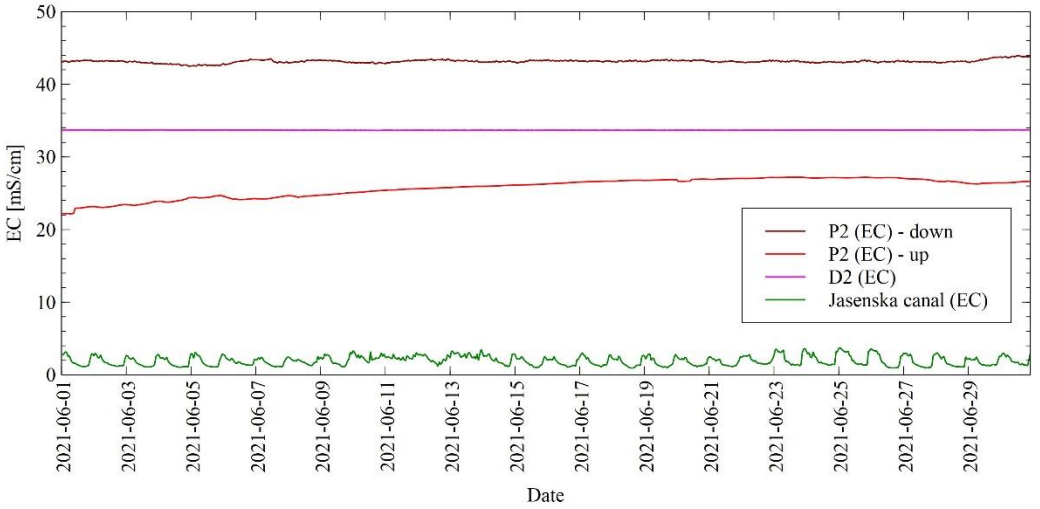


Results:
P2

- EC at the bottom of P2 has constant value, while EC closer to surface has small increase during July
- EC in confined aquifer is constant during whole month
- Piezometric head, EC and T in Jasenska canal have daily fluctutations connected to work regime of pumping station Modric

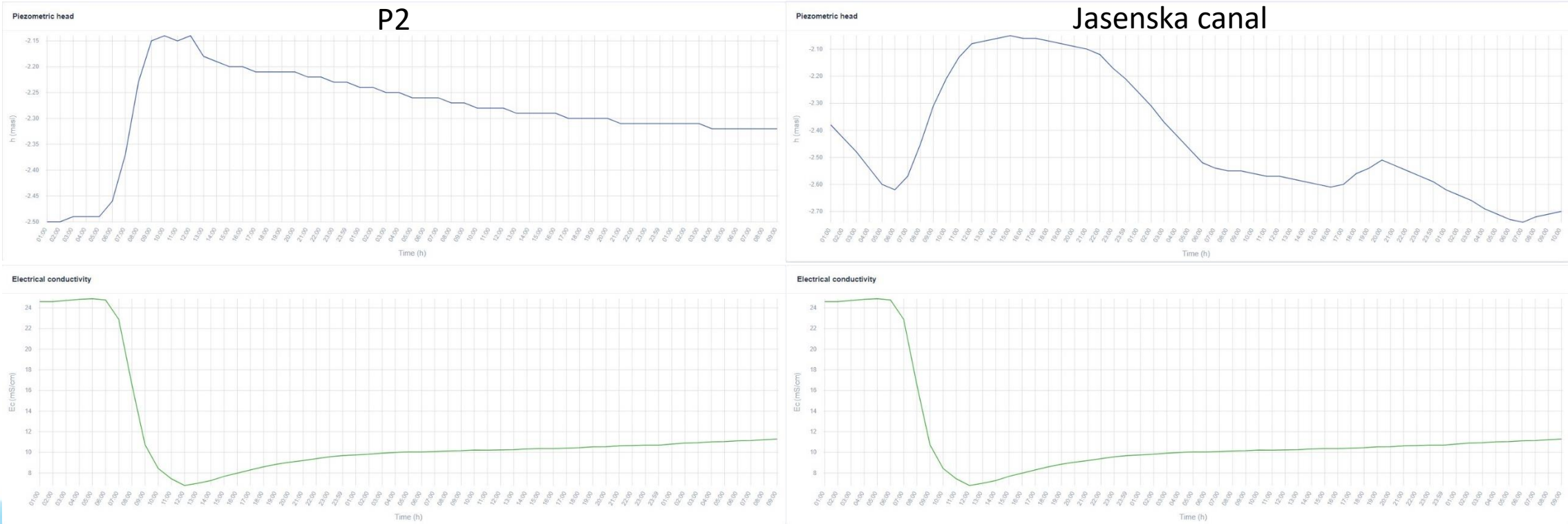






Results:
P2

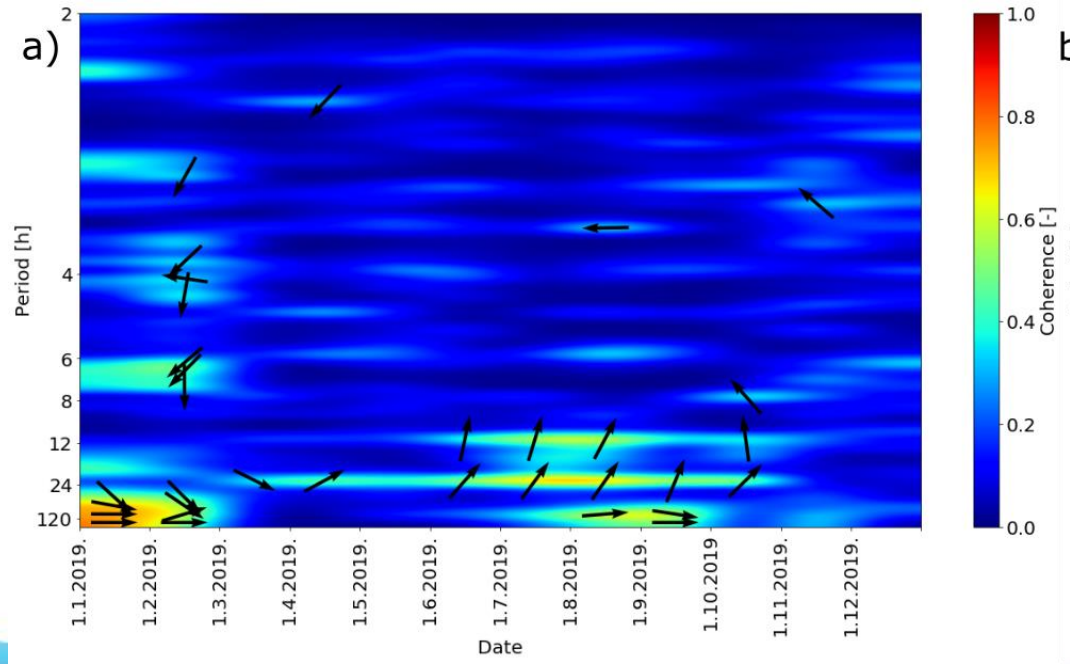
- Observed signal of piezometer head and EC in P2 in real time from *www.neretva.waveform.hr* (7.10.2021. – 9.10.2021.)



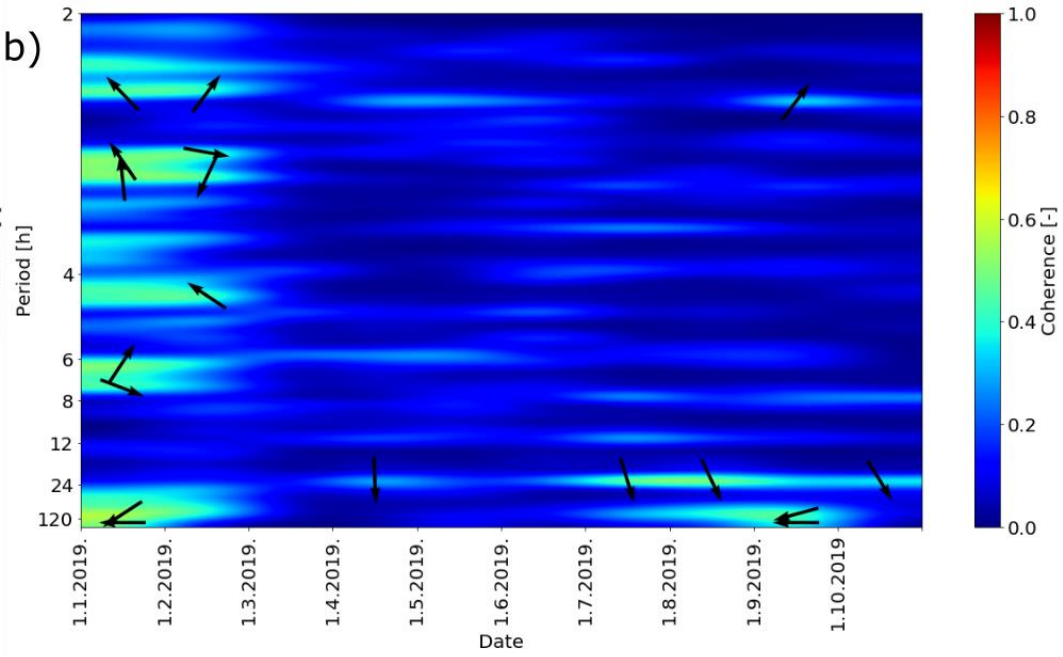
Results:
P2

- Piezometric head and EC in P2 shows significant coherence with frequencies corresponding to trend in PS Modrič water level during rainy period
- Piezometric head cohere with daily oscillations in PS Modrič during dry period

PS Modrič – P2

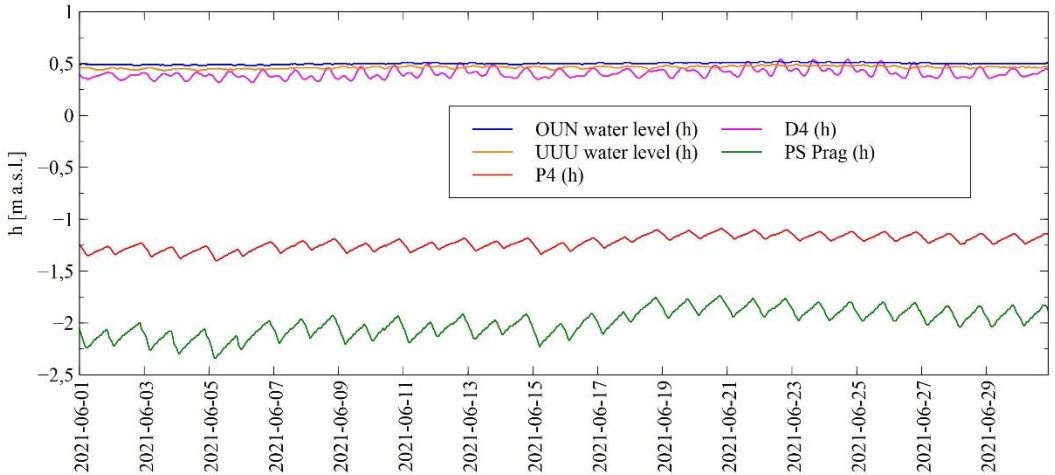


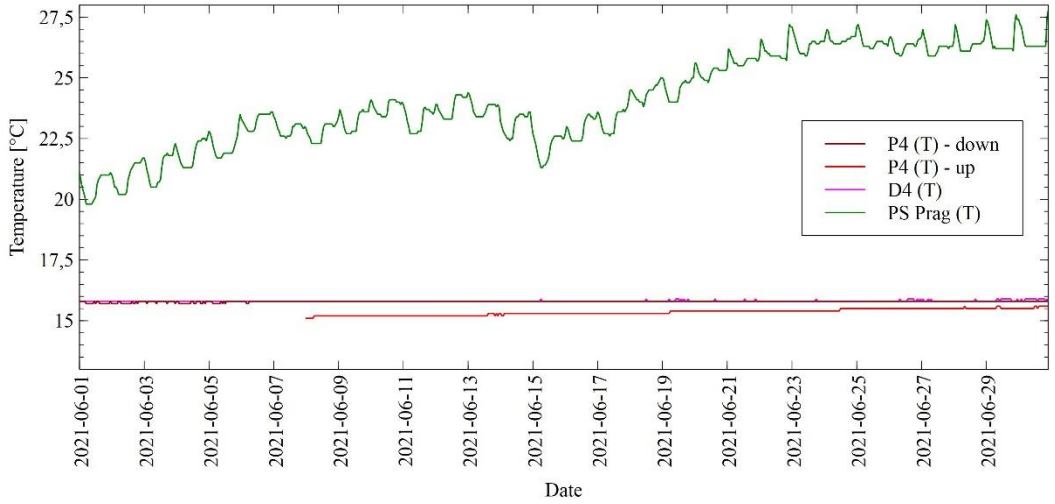
PS Modrič – P2 EC

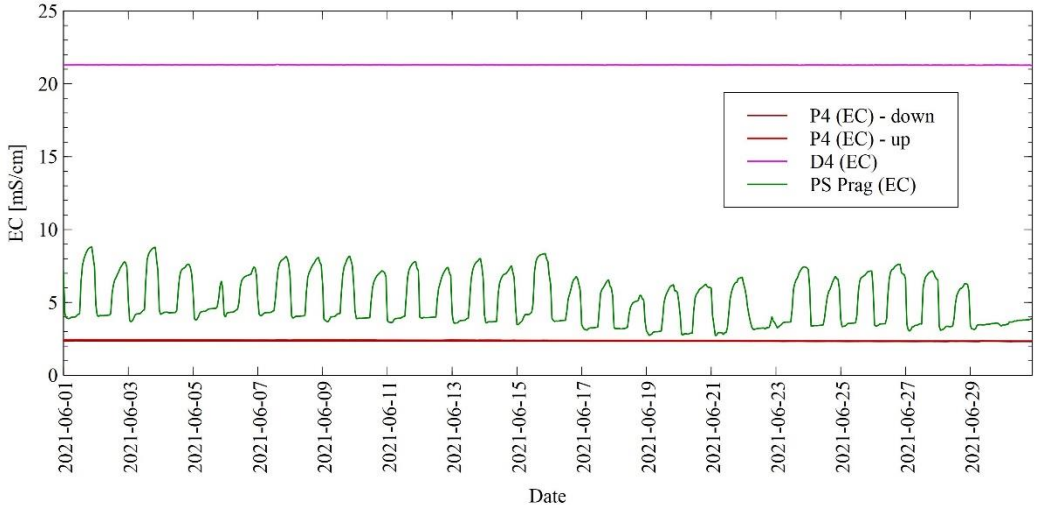


Results:
P4

- Observed signal of piezometric head in P4 corresponds to PS Prag water level with attenuation in amplitudes and higher mean value as it is expected due the proximity of Mala Neretva
- EC in P4 on both probes locations had same value during whole month



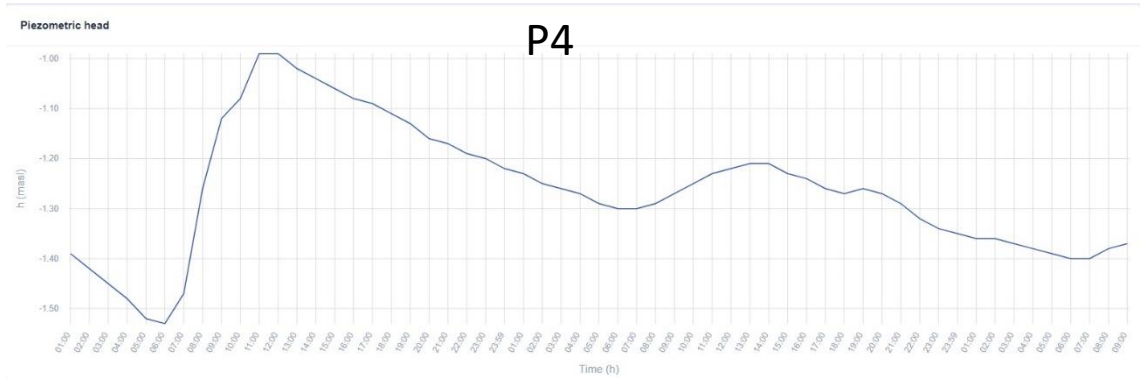


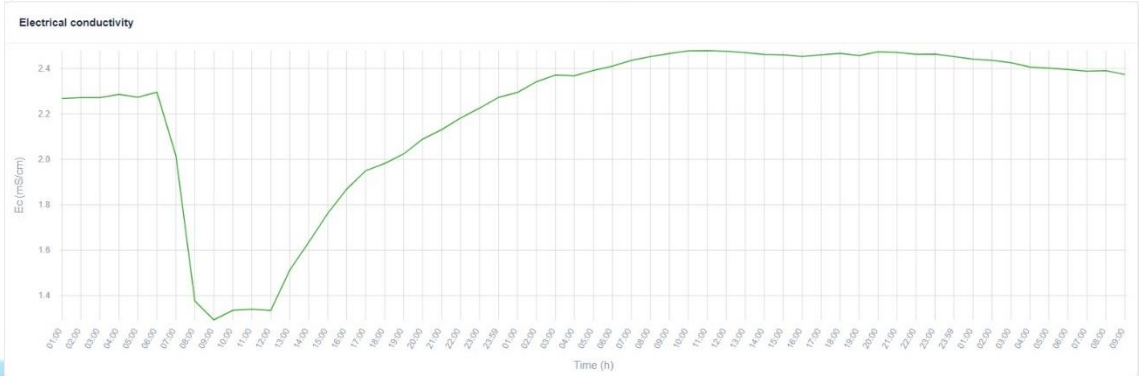


Results:
P4

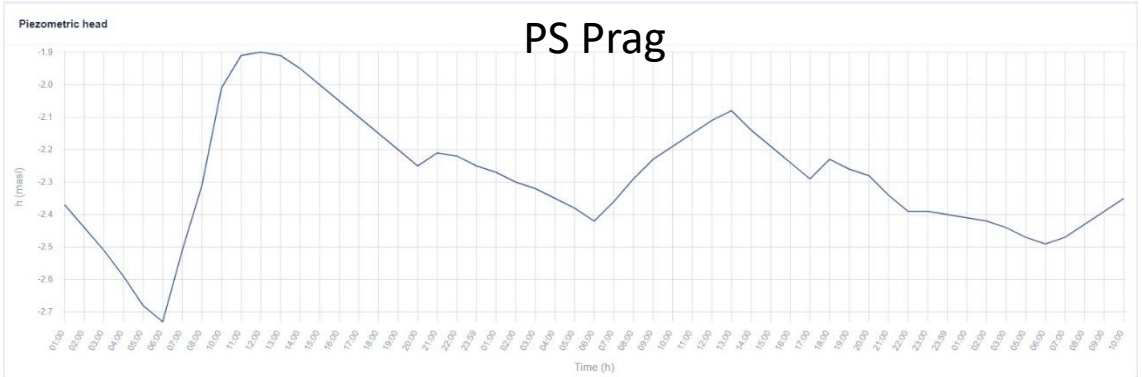
- Observed signal of piezometer head and EC in P4 in real time from *www.neretva.waveform.hr* (7.10.2021. – 9.10.2021.)

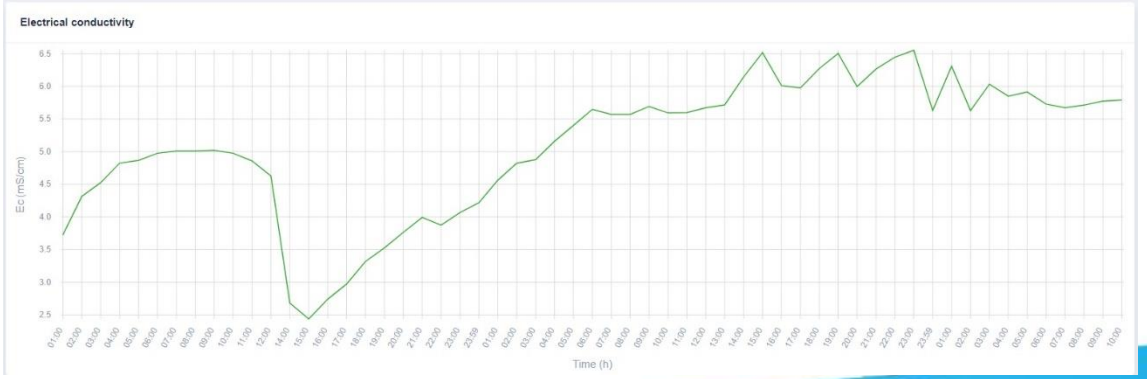
P4





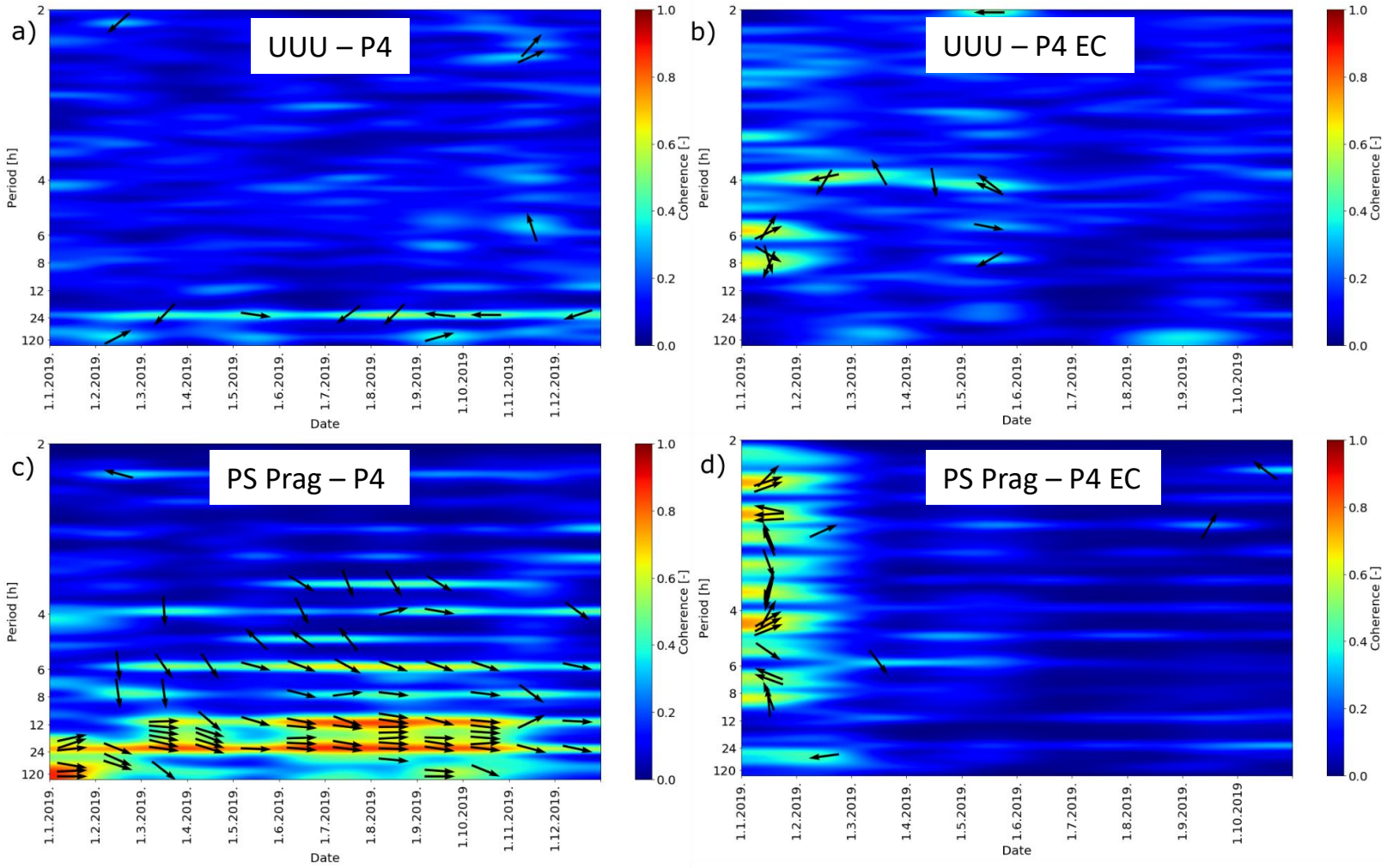
PS Prag





Results: P4

- Coherence model shows that piezometric in P4 is dominantly affected by the water level oscillations in PS Prag basin




Mala Neretva
Modrič
Sea
THANK YOU